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A DOSAGE SCHEDULE FOR CITRUS FUMIGATION WITH LIQUID HYDROCYANIC ACID[1]

By R. S. WOGLUM, *Bureau of Entomology, United States Department of Agriculture, Alhambra, Cal.*

The advent of liquid hydrocyanic acid into the field of fumigation has brought about radical changes in application and presented problems whose solutions appear necessary before the use of this recently introduced material is placed on the stable basis required for effective orchard treatment. In an effort to develop further information on this subject the writer carried on, throughout the fumigation season of 1918, extensive experiments, which included operations covering several hundred acres of orange and lemon trees, both large and small, infested with the black, purple or red scales. In this work liquid hydrocyanic acid, 95 to 98 per cent pure, was used, the application being made in the form of a spray by special machines designed for this purpose. Many parallel experiments with pot- and machine-generated gas were performed. One outcome of this study has been the accumulation of data showing that the dosage schedule originally prepared for pot-generation of gas is not fully satisfactory in its present form for use with liquid hydrocyanic acid. This paper attempts to show the comparative efficacy of liquid hydrocyanic acid and pot-generated gas, and presents a new dosage schedule adapted to citrus fumigation with liquid hydrocyanic acid, 95 to 98 per cent pure.

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[1]The writer wishes to acknowledge the assistance given by Mr. M. B. Rounds who performed an active part in much of the experimental work on which this paper is based.

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Comparative Effectiveness of Pot-generated Gas and Liquid Hydrocyanic Acid

The purity of sodium cyanide used in California since its introduction for fumigation by the writer in 1909 has averaged about 97 per cent, according to analyses made of representative samples from time to time. In pot-generation not all of the cyanogen is given off as gas but many analyses made by the Bureau of Chemistry of the United States Department of Agriculture have shown that 90 to 95 per cent (average 93 per cent) of the total available hydrocyanic acid is evolved. A 93 per cent gas evolution from a 97 per cent sodium cyanid is equivalent to 20.2 cubic centimeters of 100 per cent liquid hydrocyanic acid (60° F., specific gravity .6969), or 20.9 cubic centimeters of 96 per cent hydrocyanic acid this last purity being considered a standard for field use. The schedules in common use for fumigation in California are based on the gas delivery from sodium cyanid generated in pots; therefore, to deliver a gas equal in amount would require approximately 20.9 cubic centimeters of 96 per cent liquid hydrocyanic acid for each ounce of solid sodium cyanid in any given dosage. It happens that the machine commonly used this past season for applying liquid hydrocyanic acid in field fumigation was graduated to deliver 16.56 cubic centimeters as equivalent to each ounce of solid sodium cyanid, which is approximately 21 per cent below requirements as based on gas delivery in pot-generation. In short, where commercial fumigation in California during the past season was based on the same dosage schedule in liquid as in pot- and machine-generation there was applied approximately 21 per cent less gas to the trees under the former method than the latter.

It was shown by the writer in a paper presented at the thirty-first annual meeting of this Association that the gas distribution is essentially different in pot- or machine-generation from that obtained with liquid hydrocyanic acid under the present method of application. It is a matter of common knowledge that the best scale-kill on trees treated with pot- or machine-generated gas is toward the top of the tent, whereas in the case of trees treated with liquid hydrocyanic acid at the warmer temperatures of fumigation it was demonstrated that the killing is the best toward the bottom of the tree. Since very much the larger proportion of insects, especially the black and purple scales, is toward the bottom of the tree, the very desirable condition exists of the heaviest infestation of insects and the greatest concentration of gas being distributed at the same place. This is the ideal for effective fumigation, and is, very probably, the principle reason for the increased efficiency of liquid hydrocyanic acid over pot-generated gas.

The following experiment, which presents results typical of field experience with medium sized trees badly infested with purple scale, shows the comparative effectiveness of 98 per cent liquid hydrocyanic acid and pot-generated gas against this insect at temperatures between 65° and 70° degrees F., when the pump delivered 16.56 cubic centimeters of liquid hydrocyanic acid as corresponding to each ounce of cyanid and consequently delivered an amount of gas approximately 21 per cent less than that evolved from the pots, as previously explained.

TABLE I. COMPARATIVE SCALE-KILL AT TEMPERATURES 65° TO 70° F. BETWEEN 98 PER CENT LIQUID HYDROCYANIC ACID AND POT-GENERATED GAS. THE LIQUID HYDROCYANIC ACID WAS USED AT THE RATE OF 16.56 CUBIC CENTIMETERS AS EQUIVALENT TO 1 OUNCE SODIUM CYANID AND ON THIS BASIS THE SAME DOSAGE SCHEDULE WAS FOLLOWED.

Method of Treatment	Dosage Unit		Bottom of Trees	Top of Trees	Total for Trees
Pot System	Ozs. 97% Sodium Cyanid	Scale Examined	2168	664	2832
		Per cent Living	4.3	3.3	4.0
Liquid HCN	16.56 cc. 98% Liquid HCN as Equivalent to 1 oz. NaCN	Per Cent Living	2.7	8.4	5.4
		Scale Examined	1494	1338	2832

An examination of this table shows the results with liquid hydrocyanic acid at this strength to be better at the bottom of the trees than for the pot-generated gas, although toward the top of the trees the reverse is true, a decidedly greater percentage of scale being killed at this latter part in the case of the pot-fumigated trees. The total result for the whole tree is slightly favorable to the pot treatment and shows that, under the stated conditions, 16.56 cubic centimeters of liquid hydrocyanic acid is insufficient to produce results equivalent to 1 ounce of sodium cyanid in pot-generation.

Other experiments with medium-sized to large trees were performed against the purple scale at the higher temperatures of fumigation, using in some cases 21 to 22 cubic centimeters of liquid hydrocyanic acid as equivalent to the ounce of sodium cyanid, and where this dosage rate was applied in connection with the same schedule followed in securing the results presented in Table I the mortality average above 99 per cent. Since the average mortality of purple scale under certain conditions was shown to be 94.6 per cent with 16.56 cubic centimeters of high purity liquid hydrocyanic acid as equivalent to the ounce of sodium cyanid, and other experiments against this insect conducted under practically identical conditions with 21 to 22 cubic

centimeters of liquid hydrocyanic acid as the ounce equivalent gave a mortality above 99 per cent, it is apparent that the amount of this liquid required to produce results comparable to the 96 per cent mortality secured with pot-generation comes within the limits of 16.56 and 21 cubic centimeters and approaches the lower figure more closely than the larger. Study of our complete data on purple scale fumigation, supplemented by that on black and red scales, led to the conclusion that 18 cubic centimeters of high purity liquid hydrocyanic acid approximates the equivalent of one ounce of sodium cyanid on average sized trees fumigated at the ordinary temperatures of treatment as closely as any fixed quantity can for orchard work. These results indicate a decided economy of material over the requirements of pot-fumigated trees.

In the case of red scale on small trees the comparison is not quite as favorable toward liquid hydrocyanic acid as shown by the following experiments which are typical of many performed against this scale:

Table II. Comparative Scale-Kill on Young Trees Between Pot-Generated Gas and 97 Per Cent Liquid Hydrocyanic Acid, the Latter Used at the Rate of 16.56 Cubic Centimeters and 19.2 Cubic Centimeters to the Ounce of Solid Sodium Cyanid. The Same Dosage Schedule was Followed for All Trees.

Method of Treatment	Dosage Unit		Bottom of Tree (1 to 3 ft.)	Top of Tree (4 to 7 ft.)	Total for Tree
Pot System	Ozs. 97% Sodium Cyanid	Scale Examined	20884	28924	49808
		Per Cent Living	2.1	1.0	1.5
Liquid HCN	16.56 c.c. 97% Liquid HCN as Equivalent to 1 oz. NaCN	Scale Examined	12823	8619	21442
		Per Cent Living	2.4	5.4	3.6
Liquid HCN	19.2 c.c. 97% Liquid HCN as Equivalent to 1 oz. NaCN	Scale Examined	5597	6400	11997
		Per Cent Living	0.8	1.55	1.2

An examination of the above table shows that the results with liquid hydrocyanic acid at the rate of 16.56 cubic centimeters as equivalent to 1 ounce of solid sodium cyanid were much poorer than for the pot-treated trees. However, where 19.2 cubic centimeters of liquid hydrocyanic acid for each ounce of cyanid were used the results are about equal to pot-generated gas as taken for the whole tree. These experiments show that a slightly less amount of liquid hydrocyanic acid than pot-generated gas is required for small trees. The economy is less than for medium to large sized trees.

A New Dosage Schedule

The necessity of a special schedule for use with liquid hydrocyanic acid is at once apparent by an examination of the complete results in Tables I and II, which compare liquid hydrocyanic acid and pot-generated gas. Such a schedule has been prepared and is herewith presented. It is the product of nine months continuous field experiment and observation during which records were kept on several hundred acres of fumigated trees for the black, purple and red scales.

Dosage Schedule for Citrus-Tree Fumigation with Liquid Hydrocyanic Acid 95-98 Per Cent

Distance around in feet

	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	
10	2	2	3	3	3																														
12	3	3	3	4	4	4	4																												10
14	3	3	4	4	4	4	5	5																											12
16	4	4	4	4	5	5	5	5	5	5	5	6																							14
18	4	4	4	5	5	5	5	5	6	6	6	6	6																						16
20			4	5	5	5	6	6	6	6	7	7	7	7	7	7	7																		18
22					5	6	6	6	7	7	7	7	7	8	8	8	8	8																	20
24					6	6	6	7	7	7	7	8	8	8	8	8	9	9	9																22
26								7	7	8	8	8	8	9	9	9	9	9	10	10															24
28									8	8	8	9	9	9	9	10	10	10	10	11	11	11													26
	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	28
30										8	9	9	9	10	10	10	11	11	11	12	12	12	12	13	13										30
32											9	9	10	10	11	11	12	12	12	13	13	13	14	14	14	15									32
34												10	10	11	12	12	13	13	13	14	14	14	16	15	15	16	16								34
36												10	11	12	12	13	13	14	14	15	15	16	16	16	16	17	17								36
38													12	12	13	14	14	15	15	16	16	17	17	17	18	18	18	19							38
40																14	15	16	16	17	17	18	18	18	19	19	19	20	20	21					40
42																	16	17	17	19	19	19	19	20	20	20	21	21	22	22	22				42
44																		17	18	19	19	20	20	21	21	21	22	22	22	23	23	24			44
46																				20	20	21	21	22	22	23	23	23	24	24	24	25	25	26	46
48																				20	21	22	22	23	23	24	24	25	25	25	26	26	27	27	48
	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	
50																				21	22	23	23	24	24	25	25	26	26	27	27	28	29	29	50
52																							24	25	25	26	26	27	27	28	28	29	30	30	52
54																								25	26	27	28	28	29	29	30	31	31	32	54
56																									27	28	28	29	30	31	31	32	33	33	56
58																									28	28	29	30	31	32	33	33	34	34	58

Unit charge=18 cubic centimeters

In being based on the results of field practice rather than being a laboratory calculated schedule prepared in accordance with theories of leakage, size, shape, etc., it is to be expected that the dosage will not in every case be found to conform perfectly with mathematical calculations as based on such theories. However, it is believed that in its present form this schedule has been so carefully prepared that it will approximate uniform results in orchard treatment regardless of the size of the tree and prove fully as satisfactory as the original schedule prepared for pot-fumigation.

A critical examination of the schedule shows certain outstanding features. Small trees are dosed almost in proportion to cubical contents, larger sized trees approximate the ratio of surface area of a domed-shaped figure to its cubical contents. The tendency is for tall trees to receive a heavier dosage than low trees having the same cubical contents.

Each unit of dosage in this schedule is based on a delivery of 18 cubic centimeters of liquid hydrocyanic acid, 95 to 98 per cent pure, in the form of a very fine spray beneath the tented tree. Thus a tree 30 feet over by 40 feet around calls for 10 charges of 18 cubic centimeters (180 cubic centimeters). By graduating the machines used in generating the gas in numbers corresponding to those on the schedule and providing that each graduation delivers a charge equal to the number of cubic centimeters of which itself and 18 are the product, this schedule is made equally practical to former schedules.

This dosage schedule is based on the same dimensions of tented trees as was the original Schedule I for pot-fumigation, *i. e.*, the distance around the tented tree and the distance over the middle from ground to ground. The correct dosage for any tree is found in the square formed by the intersection of the lines running from the two numbers representing these measurements. It is expected to give results equivalent to Schedule I for potassium or Schedule I for sodium cyanid and should be substituted for these schedules wherever formerly employed in pot- or machine-generation.

At a temperature of 40° F., the superiority of liquid hydrocyanic acid to pot-generated gas is not so marked as at higher temperatures of fumigation. Therefore, it will be necessary in fumigation at such low temperatures to increase the dosage over that used during warm weather.

A three-quarter or 75 per cent schedule was originally prepared by the writer for pot work and many others, such as 65, 85, 110, 120 and 125 per cent schedules have been calculated by others. The necessity of such a large number of schedules is questionable. Furthermore, the original identity of these schedules is frequently lost by field use and thereby sometimes becomes a source of confusion to the fumigator. The preferable method, and the one advocated at this time by the writer, is to have differently graduated attachments which are easily and quickly adjustable to liquid "gas" machines when different schedules are required. These will insure uniformity for all dosages and require only one dosage chart for all fumigation. Such attachments graduated on the unit delivery basis of 14 cubic centimeters, 16 cubic centimeters and 20 cubic centimeters, when used with the new dosage chart, will produce the equivalent of 78, 89 and 111 per cent schedules,

and meet the major demands in orchard fumigation. A limited stock of 22 cubic centimeter graduated attachments would assure a correct delivery to those few fumigators who occasionally use 120 to 125 per cent schedules.

The purchase of liquid hydrocyanic acid should be by the pound. One pound of 96 per cent liquid hydrocyanic acid (60° F., specific gravity .702) measures 647 cubic centimeters and contains 36 charges of 18 cubic centimeters.

RESPONSE OF THE EGGS OF APHIS AVENÆ FAB. AND APHIS POMI DEG. TO VARIOUS SPRAYS, PARTICULARLY CONCENTRATED LIME-SULFUR AND SUBSTITUTES, SEASON OF 1918–1919

By ALVAH PETERSON, *Assistant Entomologist, New Jersey Agricultural Experiment Station*

For three seasons, 1916–1919, careful observations have been made on the behavior of three important species of plant lice occurring on apple trees: *A. avenæ** Fab., *A. pomi* DeG., and *A. sorbi* Kalt. In this paper particular attention is given to the behavior of the egg stage of two species and their response to various chemicals and common contact sprays. Additional observations have been made on the influence of environmental factors, particularly evaporating factors, on the eggs during the entire dormant season and also a distinct relationship has been found to exist between the killing efficiency of the spray material and its spreading quality, but space will not permit a report on these points at this time. The author's observations for 1916–1918, and also important observations made by Dr. T. J. Headlee, may be found in the papers cited below.[1]

During the past season, 1918–1919, many of the observations and experiments, particularly spraying experiments conducted the pre-

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**Aphis avenæ* Fab. referred to is apparently *Aphis prunifoliæ* Fitch and *Aphis sorbi* Kalt. is *Aphis malifoliæ* Fitch.

[1]Headlee, T. J., 1916. Apple Plant Lice. In N. J. Agr. Expt. Sta. 38th Ann. Rept., pp. 494–501.

Headlee, T. J., 1918. Some Important Orchard Plant Lice. In N. J. Agr. Expt. Sta. Bull. 328.

Peterson, Alvah, 1917. Studies on the Morphology and Susceptibility of the Eggs of *Aphis avenæ* Feb., *Aphis pomi* DeGeer, and *Aphis sorbi* Kalt. In Jour. Econ. Ent., Vol. 10, pp. 556–560.

Peterson, Alvah, 1919. Some studies on the Eggs of Important Apple Plant Lice. In N. J. Agr. Expt. Sta. Bull. 332.

vious years, were repeated and the results obtained were almost identical with those of former years.

Observations

The eggs of *A. avenæ* were exceedingly abundant in many orchards throughout New Jersey during 1918–1919, particularly in the central and southern parts. This species was the only one present in John Barclay's orchard near Cranbury, N. J. Consequently all of the 75,000 eggs of *A. avenæ* used in the various spraying experiments were obtained from this orchard. No other species was seen from October 10 to December 10, 1918, when the females were depositing their eggs and also the nymphs observed after March 21, 1919, were *A. avenæ*. The eggs were present in such large numbers that they could be found on the smaller branches of all the trees and in many cases on the large branches. Some of the trees (ten years old) had eggs scattered over the entire length of the main trunk. The 50,000 or more eggs of *A. pomi* used in the various experiments were collected from young orchards in the northern section of the state near Lyons and Chester. The eggs of *A. sorbi* were not plentiful in any of the orchards examined this past year. A large number of orchards were observed during October, November and December, 1918, and wherever *A. sorbi* was seen the insects were few in number compared with *A. avenæ* which was always present. The scarcity of *A. sorbi* made it impractical to conduct experiments with this species.

The great abundance of *A. avenæ* this year made it possible to observe the injury done by this species. Where *A. avenæ* was the only species present on a tree it was noted that comparatively few of the leaves were curled even though the undersides of the leaves might have a large number of aphides on them. In contrast to this it was noted that whenever *A. sorbi* or *A. pomi* was present, even in small numbers (2 to 6), the leaves were badly curled and stunted. All three species were also found in large numbers on the petioles of the flowers in the pink bud and flower stage and it is probable that they may injure the set of the fruit. It is a well known fact that *A. sorbi* causes clusters of small distorted fruit but, so far as known, this is not true of *A. avenæ*. The stem mothers of *A. avenæ* give rise to nymphs, the majority of which develop wings and these migrate to other plants, thus disappearing almost completely by May 15 to 30. *A. sorbi* continues to live on the apple plant for several generations (3 to 4) and does not completely disappear from the apple tree until the last of June, while *A. pomi* lives on the apple tree the entire year.

The observations made this season indicate that the injury caused by *A. avenæ* is not serious under ordinary conditions; consequently if

this is the only species present in the orchard a great amount of injury will not take place. The only way to be sure *A. sorbi* and *A. pomi* are not present is to make a careful determination of the adult forms during the fall of the year. Observations made at this time will give one a fair estimate as to what species will be troublesome in the spring. Careful examinations of numerous orchards throughout the state for three years during October, November and December, has shown that where aphides are present 75 per cent or more of infested orchards possess some or many adults of *A. sorbi*. The black shiny eggs of *A. sorbi* and *A. avenæ* resemble each other and they are deposited by the female in similar situations (usually on the second year wood), consequently it is impossible to distinguish the two species during the dormant season. The first nymphs to hatch in the spring are *A. avenæ* (usually at the time when the fruit buds first show green) and these may be distinguished from *A. sorbi* and *A. pomi* which hatch 10 to 14 days after *A. avenæ*. In New Jersey the eggs of *A. sorbi* and *A. pomi* hatch too late to safely or satisfactorily apply a delayed dormant spray of lime-sulfur and nicotine during or after the eggs of these species have hatched. Consequently it is not advisable to wait until the hatching period of *A. sorbi* and *A. pomi* has passed in order to determine the presence of the injurious species and then attempt to obtain a satisfactory control.

The above facts concerning plant lice eggs on apple trees leads to the conclusion that it is highly advisable to apply a delayed dormant spray if aphid eggs are found on the trees, during the dormant season. If one has made a careful examination of the adult forms during October, November and December, and is certain that *A. avenæ* is the only species present, it might be safe to ignore the presence of the aphid eggs on apple trees.

Morphology and Behavior of the Eggs

Observations on the morphology and the behavior of aphid eggs were repeated this past season and it was again observed that the eggs of *A. avenæ* and *A. pomi* (for observations on *A. sorbi* see N. J. Agr. Expt. Sta. Bull. 332) show two distinct layers in the egg shell, an outer, semi-transparent layer which is soft and glutinous when the egg is deposited, and an inner soft elastic membraneous black layer. After the egg is deposited the outer layer hardens and becomes somewhat tough and impervious upon long exposure to weather. A third layer or skin may be seen about the nymph when it emerges. This is an embryonic membrane or the first exuvium. It is shed by *A. avenæ* when the nymph is half-way out of the shell, while with *A. pomi* it is not shed until the nymph is practically free from the entire

egg. The egg burster or elevated ridge on the meson of the cephalic aspect of the head in both species disappears at the time the skin or exuvium splits and is shed, consequently it must be a part of the embryonic membrane or exuvium.

In both species the outer layer of the egg usually splits along the dorso-mesal line a number of days before the nymph emerges. This splitting of the outer layer of the egg is also characteristic of eggs of other species of plant lice. A number of undetermined eggs of plant lice found on various trees (willow, etc.) were examined during March and their outer layers split in a manner similar to aphid eggs found on apple trees. If aphid eggs in general are similar in construction and behavior in hatching to aphid eggs on apple trees then the response of various species of aphid eggs to environmental factors might be the same. Under these conditions it is probable that evaporating factors have considerable influence on the percentage of hatch. During the past season at New Brunswick the first eggs of *A. avenæ* with a split outer shell were seen on February 10. The percentage of eggs of *A. avenæ* showing this split condition continued to increase and when the eggs started to hatch in large numbers on March 21, 35 to 40 per cent of the eggs showed a split outer shell and from 60 to 65 per cent of the eggs hatched in 1919.

The hatching period during 1919 lasted from March 21 until April 6. This prolonged period was due to the fact that on March 28, when 55 per cent of the eggs had hatched, a decided drop in the temperature took place and this continued for five or six days, thus delaying the completion of the hatching until April 3 to 5.

The first eggs of *A. pomi* at New Brunswick with a split outer covering were seen on March 3 and on March 21, 25 to 35 per cent had split their outer shells. *A pomi* started to hatch rapidly between April 5 and 10 and the hatching period was completed by April 20. From 50 to 55 per cent of the eggs of this species hatched in 1919. The eggs of this species were found on first year wood and collected from a young apple orchard near Lyons and Chester, N. J. It is possible that a few of them, not over 10 per cent, were eggs of *A. avenæ* and *A. sorbi*. On April 22, the particular trees at Lyons from which the majority of eggs were collected for experimental purposes were examined and the young leaves were covered with aphides. After observing several hundred insects, 4 per cent were *A. avenæ*, 7 per cent were *A. sorbi*, and 89 per cent were *A. pomi*. Even though this count is correct it is probable that many of the nymphs of *A. avenæ* and *A. sorbi* seen on the terminal fruit buds came from eggs located on the second year wood (second year wood was not used in experiments with *A. pomi*).

Methods

Whenever material was needed for experimental purposes, collections were made from the above mentioned orchards and the material was kept out-of-doors all the time and exposed to all conditions of the weather except for the few minutes required to examine the eggs under a binocular microscope in order that all the abnormal appearing eggs (shriveled, hatched or light colored eggs) might be removed and the normal eggs counted. A string tag was placed on each twig (8 to 12 inches long) and on it was written the number of the experiment, total number of normal eggs, species, and source of the material.

The number of normal eggs of *A. avenæ* and *A. pomi* used in each spraying experiment in 1918–1919 was 200 to 300 and 300 to 500, respectively, while in 1917–1918 only 100 to 150 eggs were used. This increase over previous years reduced the possibility of experimental error to a minimum. The consistent regularity of the plotted lines on the charts shows the minimum nature of the experimental error in the spraying experiments for 1918–1919. The eggs of *A. avenæ* were sprayed at regular intervals throughout the season; on December 7, 1918, January 9, February 10, March 1, March 10 and March 21, 1919, while the eggs of *A. pomi* were sprayed on February 18, March 3, March 12 and March 21, 1919. No dormant sprays were applied after March 21 because at that time the fruit buds showed green and were in the proper stage for the application of a delayed dormant spray. Any recommended dormant spray applied after April 3 in the southern part of New Jersey in 1919 would have injured most varieties of apple trees. Furthermore, many hatched nymphs after April 3 were protected by the young leaves.

The following substances were used at varying strengths and some in combination with each other in the spraying experiments: concentrated liquid lime-sulfur (Mechling Bros. Mfg. Co., Camden, N. J.), dry lime-sulfur (The Sherwin-Williams Co., Newark, N. J.), barium-sulfur ("B. T. S.," General Chemical Co., New York City), sodium-sulfur ("Soluble sulphur," Niagara Sprayer Co., Middleport, N. Y.), sodium sulfo-carbonate (The Dow Chemical Co., Midland, Mich.), hydrated lime, miscible oil ("Scalecide," B. G. Pratt Co., New York City), nicotine ("Black Leaf 40," The Kentucky Tobacco Product Co., Louisville, Ky.), fish oil soap, paste form (Capstone Mfg., Newark, N. J.), "Fels Naphtha" laundry soap, linseed oil, cotton seed oil crude carbolic acid, cresol U. S. P., etc. All of the sprays were applied to the twigs by means of a small hand atomizer connected with a foot pump. The twigs were held several inches from the tip of the atomizer and all sides of each twig were thoroughly hit once, thus coating every egg. After all the twigs of one experiment were sprayed they were

tied together and then suspended in a perpendicular position on two wires which ran across the upper portion of a large empty wooden box. The large boxes were located out-of-doors in an open spot near the laboratory, and thus the twigs were exposed to all weather conditions, similar to that of the orchard. The above laboratory method of spraying and caring for the eggs is somewhat ideal, yet the results obtained for the past three seasons have been very satisfactory in ascertaining the exact effect of each spray and their comparative values. The results of this laboratory method have exactly duplicated the results obtained in the orchard where lime-sulfur 1–9, lime-sulfur 1–9 plus nicotine 1–500 and "Scalecide" 1–15 have been used. During 1918–1919 the above out-of-door laboratory method for determining the value of various sprays in killing the eggs has been relied upon almost entirely. In several orchards a few observations were made on the effect of lime-sulfur, 1–9 plus nicotine, 1–500 and the results corresponded with results of similar experiments at the laboratory.

Contact Sprays

Previous morphological and ecological studies on the eggs of plant lice found on apple trees show conclusively that they may be killed by various contact sprays. It has been shown that the eggs are most susceptible to environmental factors and various chemicals just previous to the hatching period. The period of susceptibility commences about the first week in March with *A. avenæ* and probably a week or ten days later with *A. pomi*. At this time the eggs are commencing to rapidly split their outer coats. The maximum susceptibility of the majority of the eggs probably occurs just at the time the eggs are starting to hatch in large numbers because at this stage the largest percentage have split their outer shells preparatory to severing the inner black membrane. This season's results indicate that the susceptibility of the eggs of *A. avenæ* and *A. pomi* to various sprays are approximately the same while observations made in 1917 indicate that the eggs of *A. sorbi* and *A. pomi* are somewhat more resistant to various sprays than eggs of *A. avenæ*. Undoubtedly the different sprays act on the eggs in various ways. Some may act as desiccators (probably lime-sulfur and others) which harden the outer shell more or less or extract the water content from the embryo (especially if applied after the outer layer has split). Other substances soften and disintegrate the outer highly impervious layer (crude carbolic acid), thus exposing the inner layer to evaporating factors. The physical reaction of contact insecticides may be important, but it is probable that the toxic effect of various insecticides upon the embryo is much more important. This is a point that is diffcult to determine.

Table I. Percentages of Hatch (Selected Eggs of A. avenæ Kept Out-of-Doors) When Eggs were Coated with Contact Sprays on December 7, 1918, January 9, February 10, March 1, March 10 and March 21, 1919 (200–300 Eggs in Each Trial)

Plotted Expts. on Charts	Serial Number	Spray	Sprayed December 7, 1918	Sprayed January 9, 1919	Sprayed February 10, 1919	Sprayed March 1, 1919	Sprayed March 10, 1919	Sprayed March 21, 1919
a	1	Liquid lime-sulfur, 1–9..................	31	17	8	7	6.7	6.2
b	2	Liquid lime-sulfur, 1–6..................	28	13	8	1	0.6	4.6
c	3	Liquid lime-sulfur, 1–9 plus casein-lime, 1 gm.–100 cc..........................	25	10	6	1.5	0	1.7
d	4	Liquid lime-sulfur, 1–6 plus casein-lime, 1 gm.–100 cc..........................	21	11	3	1.7	0	1
	5	Dry lime-sulfur (S-W), 10 lb.–50 gal......			38	49	12	24
e	6	Dry lime-sulfur (S-W), 15 lb.–50 gal.......			39	35	22	25
f	7	Dry lime-sulfur (S-W), 20 lb.–50 gal.......			37	23	11	8
g	8	Dry (dust form) lime-sulfur (S-W), 15 lb.–50 gal...............................			36	20	10	8
	9	"B. T. S.," 10 lb.–50 gal................			36	34	30	24
h	10	"B. T. S.," 15 lb.–50 gal................			33	21	11	15
	11	"B. T. S.," 20 lb.–50 gal................			41	12	10	8.5
i	12	"Soluble sulfur," 15 lb.–50 gal...........			29	12	16	6.7
	13	Liquid sodium sulfo-carbonate, 1–9.......					[1]1.5	1.7
	14	Liquid sodium sulfo-carbonate, 1–14......						1.0
	15	Liquid sodium sulfo-carbonate, 1–19......						7
j	16	Liquid lime-sulfur, 1–9 plus nicotine, 1–500.	6	7	6	0	1	0
k	17	Liquid lime-sulfur, 1–6 plus nicotine, 1–500.	0.6	6	3	0	0	0
l	18	Liquid lime-sulfur, 1–9 plus casein-lime, 1 gm.–100 cc. plus nicotine, 1–500........	0	4	4	0	0	0
m	19	Liquid lime-sulfur, 1–6 plus casein-lime, 1 gm.–100 cc. plus nicotine, 1–500........	0	2	2	0	0	0
	20	Dry lime-sulfur (S-W), 10 lb.–50 gal. plus nicotine, 1–500......................			25	0	6.5	3
n	21	Dry lime-sulfur (S-W), 15 lb.–50 gal. plus nicotine, 1–500......................			18	1	0.9	1.5
	22	Dry lime-sulfur (S-W), 20 lb.–50 gal. plus nicotine, 1–500.....................			7	0	0.5	1.4
o	23	Dry (dust form) lime-sulfur (S-W), 15 lb.–50 gal. plus nicotine 1–500............			9	2	0.9	1.4
	24	"B. T. S.," 10 lb.–50 gal. plus nicotine, 1–500..............................			8	2	0.9	9
p	25	"B. T. S.," 15 lb.–50 gal. plus nicotine, 1–500..............................			17	1	0.0	2.4
	26	"B. T. S.," 20 lb.–50 gal. plus nicotine, 1–500..............................			12	0	0.5	0

[1]Sprayed March 18, 1919.

TABLE I.—*Concluded*

Plotted Expts. on Charts	Serial Number	Spray	Sprayed December 7, 1918	Sprayed January 9, 1919	Sprayed February 10, 1919	Sprayed March 1, 1919	Sprayed March 10, 1919	Sprayed March 21, 1919
q	27	"Soluble sulfur," 15 lb.–50 gal. plus nicotine, 1–500			5	2.6	0.0	0.9
	28	Liquid sodium sulfo-carbonate, 1–9 plus nicotine, 1–500					[1]0.3	0.0
r	29	Hydrated lime, 1.75 gm.–50 cc.		70	58	42	26	20
	30	Hydrated lime, 1.75 gm.–50 cc. plus casein-lime, .25 gm.–50 cc.		67	58	25	30	17
	31	Hydrated lime, 3.5 gm.–50 cc.		55	44	44	19	26
s	32	Hydrated lime, 3.5 gm.–50 cc. plus casein-lime, 0.5 gm.–50 cc.		49	48	31	13	17
u	33	Fish-oil soap, 1 gm.–50 cc.			64	62	48	15
v	34	Fish-oil soap, 1 gm.–50 cc. plus nicotine, 1–500	48	55	19	23	16	1.1
	35	Fish-oil soap, 1 gm.–100 cc. plus nicotine, 1–500	50	60	50	58	31	2
y	36	Fish-oil soap, 1 gm.–50 cc. plus crude carbolic acid, 2 cc.–98 cc.		58	56	45	22	2.8
	37	Crude carbolic acid, 2 cc.–98 cc.		67	56	71	58	10
t	38	"Scalecide," 1–15	42	52	36	23	27	9
	39	"Scalecide," 1–15, plus soap, 1 gm.–200 cc.			35	33	32	12
	40	"Scalecide," 1–25 plus soap, 1 gm.–200 cc.			45	50	46	24
z	41	Linseed Oil, 8 cc.–92 cc. plus laundry soap, 1 gm.–100 cc.			50	33	36	6
	42	Linseed Oil, 8 cc.–92 cc. plus laundry soap, 1 gm–100 cc. plus crude carbolic acid, 1 cc–99 cc.			66	39	35	1
z-2	43	Cotton-seed oil, 8cc.–92cc. plus laundry soap, 1 gm.–100 cc.			68	52	46	8
	44	Cotton-seed oil, 8 cc.–92 cc. plus laundry soap, 1 gm.–100 cc. plus crude carbolic acid, 1 cc.–99 cc.			40	46	30	6
	45	Checks (300–500 eggs in each)	72	75	75	60	61	62
		Percentage of eggs showing a split in outer shell	0	0	1	3–8	15–20	35–40

[1] Sprayed March 18, 1919.

The purpose of this past season's spraying experiments has been to repeat all the experiments of previous years which give some promise of becoming important sprays for the control of aphides in the egg stage; to determine the comparative value of recommended (and other) winter strengths of concentrated liquid lime-sulfur, dry (coarse and fine powder) lime-sulfur, barium-sulfur ("B. T. S.") and sodium sulfur

("Soluble sulphur"), each by itself and each in combination with nicotine (Black Leaf 40, 1–500); to try out various other sprays and combinations and also to make a preliminary determination of the value of spreaders for any contact insecticide which might be used to kill aphid eggs.

The results of the majority of the spraying experiments for 1918-1919, with the eggs of *A. avenæ* and *A. pomi*, may be found in Tables I and II respectively. The two tables show for every spray the serial number, the letter representing the spray on the charts (if plotted) and the dates of application. The numbers to the right of each spray are the percentages of hatch of 200 to 500 eggs sprayed on the dates indicated at the top of each column. The spray solutions were made up in liter quantities or fractions thereof (100 cc.). A solution reading as follows: linseed oil 8 cc.–92 cc. plus laundry soap 1 gm.–100 cc. plus crude carbolic acid 1 cc.–99 cc. means that in 100 cc. of the spray mixture there is 8 cc. of linseed oil, 1 gm. of soap and 1 cc. of crude carbolic acid. The same thing is true with all other sprays represented in the tables.

The most important series of experiments have been plotted in Charts I–V. Each spray has been given a definite letter which is the same for all the charts. The key on page 381 or the letters in the first column of Tables I and II show what each letter stands for. The charts show on the top line the date of application, while the columns of figures to the left and right indicate the percentage of hatch and the percentage of kill, respectively. The point of intersection of the plotted lines with the perpendicular date lines (date of application) indicates the percentage of hatch if one examines the column of figures to the left and the percentage of dead eggs if one examines the column of figures to the right. The percentage figures at the bottom of the chart show the approximate percentage of eggs with a split outer shell on the respective dates when the applications were made.

The majority of plotted experiments show a gradual and regular increase in effectiveness from the first applications made in December, January and February to the last made on March 21, 1919. In a few series of experiments and in the checks as well there is some irregularity. This irregularity may be due to the fact that occasionally one may work with a few abnormal eggs and still not be aware of it at the time when the spray is applied. The use of a large number of eggs in each experiment and the fact that collections were made from various trees in the same orchard largely eliminates the possibility of serious experimental error. In Charts II and III it will be noted that on March 21 some of the experiments show a slight increase in the percentage of hatch where applications were made on this date. This

TABLE II. PERCENTAGES OF HATCH (EGGS OF A. POMI KEPT OUT-OF-DOORS) WHEN EGGS WERE COATED WITH CONTACT SPRAYS ON FEBRUARY 18, MARCH 3, MARCH 12 AND MARCH 21, 1919. (300–500 EGGS IN EACH TRIAL)

Plotted expts. on chart 5	Serial Number	Spray	Sprayed February 18, 1919	Sprayed March 3, 1919	Sprayed March 12, 1919	Sprayed March 21, 1919
a	1-p	Liquid lime-sulfur, 1–9	14	11	7	4
b	2-p	Liquid lime-sulfur, 1–6	10	3.7	4.3	0.5
	3-p	Liquid lime-sulfur, 1–9 plus casein-lime, 1 gm.–100 cc.			3.1	0
e	4-p	Dry lime-sulfur (S-W), 15 lb.–50 gal.	15	15	20	9
	5-p	Dry (dust form) lime-sulfur (S-W), 15 lb.–50 gal.				6
h	6-p	"B. T. S.," 15 lb.–50 gal.	18	20	10	12
i	7-p	"Soluble sulphur," 15 lb.–50 gal.	8.5	16	15	8.3
	8-p	Liquid sodium sulfo-carbonate, 1–9				0
j	9-p	Liquid lime-sulfur, 1–9, plus nicotine, 1–500	3.7	2.8	0	1.6
k	10-p	Liquid lime-sulfur, 1–6 plus nicotine, 1–500	2.7	0	0	0
	11-p	Dry lime-sulfur (S-W), 15 lb.–50 gal. plus nicotine, 1–500				2
	12-p	Dry (dust form) lime-sulfur (S-W), 15 lb.–50 gal., plus nicotine 1–500				0
	13-p	"B. T. S.," 15 lb.–50 gal. plus nicotine, 1–500				0
	14-p	"Soluble sulphur," 15 lb.–50 gal. plus nicotine, 1–500				0
	15-p	Liquid sodium sulfo-carbonate, 1–9 plus nicotine, 1–500				0
	16-p	Fish-oil soap, 1 gm.–50 cc.			33[1]	8
	17-p	Fish-oil soap, 1 gm.–50 cc. plus nicotine, 1–500				3
w	18-p	Fish-oil soap, 1 gm.–100 cc. plus nicotine, 1–500	44	33	28	13
	19-p	Fish-oil soap, 1 gm.–50 cc. plus crude carbolic acid, 2 cc.–98 cc.				13
	20-p	Crude carbolic acid, 2 cc.–98 cc.	61	44	62	15
t	21-p	"Scalecide," 1–15	41	35	14	12
	22-p	"Scalecide," 1–15 plus laundry soap, 1 gm.–200 cc.		11	20	1
	23-p	"Scalecide," 1–25 plus laundry soap, 1 gm.–200 cc.			23	23
	24-p	Linseed Oil, 8 cc.–92 cc. plus laundry soap, 1 gm.–100 cc.			20	9
	25-p	Linseed Oil, 8 cc.–92 cc. plus laundry soap, 1 gm.–100 cc. plus crude carbolic acid, 1 cc.–99 cc.				3.5
	26-p	Cotton-seed oil, 8 cc.–92 cc. plus laundry soap, 1 gm.–100 cc.			14	10
	27-p	Cotton-seed oil, 8 cc.–92 cc. plus laundry soap, 1 gm.–100 cc. plus crude carbolic acid, 1 cc.–99 cc.				8
	28-p	Check	60	62	62	47
		Percentage of eggs showing a split in outer shell	0	1–5	5–15	25–35

[1] Fish-oil soap, 1 gm.–100 cc. of water.

increase is probably an experimental error. The eggs started to hatch rapidly on March 21 and it was necessary to reëxamine each twig before it was sprayed in order to remove or count all hatched eggs. Under these conditions, when it was necessary to work rapidly, it is possible that some of the hatched eggs or eggs where the nymphs had just severed the inner pigmented membrane, were overlooked.

Chart I shows the results of some spraying experiments with the eggs of *A. avenæ* for the season of 1917–1918. Comparing the lines in this chart with those of similar experiments on Charts II, III and IV (spraying experiments with the eggs of *A. avenæ* for 1918–1919), there is a decided similarity in the comparative value of various sprays in killing the eggs of *A. avenæ* for the two seasons. In a few series of experiments for the two seasons there is a marked difference in the angle at which the lines of various plotted experiments cross the chart. In the 1918–1919 charts the lines are more nearly perpendicular due to the fact that 65 to 70 per cent of the selected eggs in the checks of *A. avenæ* hatched in 1919, while in 1918 only 45 to 50 per cent hatched. This difference is especially noticeable with sprays which produce little or no effect on the eggs when applied during December, January or February (Expt. t, u, and v).

Liquid and Dry Lime-Sulfur and Substitutes

Concentrated liquid lime-sulfur at the recommended winter strength, 1–9 (or 1–6) is superior to all other sprays (when used at their respective recommended strengths) in killing the eggs of apple plant lice. Applications of lime-sulfur, 1–9 made during March, 1919, killed 92 to 94 per cent of all the eggs of *A. avenæ* and 89 to 96 per cent of all the eggs of *A. pomi* (Table I and II and Charts I–V). Lime-sulfur, 1–6 is somewhat superior to 1–9, but in no instance did it bring about a complete kill. Casein-lime, 1 gm.–100 cc. added to lime-sulfur seems to materially increase the effectiveness of both strengths of lime-sulfur, killing 98 to 100 per cent during March. The casein-lime used as a spreader was composed of fifty per cent casein (lactic) and fifty per cent hydrated lime.

Lime-sulfur in a dry state, commercially known as dry lime-sulfur, was given a thorough try out and in all cases where it was used (Expt. 5, 6, 7 and 8, Table I and Expt. 4-p, and 5-p Table II) at the rate of 10, 15 and 20 pounds to 50 gallons of water the percentage of kill of the eggs of *A. avenæ* and *A. pomi* was decidedly below that of concentrated liquid lime-sulfur, 1–9. For dormant spraying the manufacturers (Sherwin-Williams Co.) recommend 10 to 14 pounds to 50 gallons of water. At the rate of 15 pounds to 50 gallons the greatest percentage of kill of the eggs of *A. avenæ* was 78 per cent while 94 per

cent were killed with concentrated lime-sulfur, 1–9 (see Charts II and V).

Dry lime-sulfur may be secured in two forms, a coarse powder which is recommended for liquid spraying and a finely ground powder which is suitable for dusting. The two forms behave differently when dissolved in water. Using amounts (thoroughly dried) equivalent to 14 pounds to 50 gallons of water only 65 to 67 per cent of the coarse product dissolved in water in thirty minutes (thoroughly agitated) while 88 per cent of the fine powder dissolved under the same conditions. In other tests similar to the above, except for the fact that the residue in the filter was thoroughly washed, 74.2 per cent of the coarse form dissolved while 90.3 per cent of the fine powder dissolved. The insoluble character of dry lime-sulfur, particularly the coarse form, is undoubtedly objectional. To be most effective in spreading and as a contact insecticide all the lime-sulfur should be soluble. A chemical analysis of dry lime-sulfur shows approximately 55 per cent sulfur in the dry product. When this product is used at the recommended winter strength, 14 pounds to 50 gallons of water, figures show that the spray, as it goes to the tree, contains approximately 50 per cent as much sulfur per gallon as the recommended liquid lime-sulfur 1–9.

The poor soluble character of dry lime-sulfur and the low sulfur content of the recommended winter strength probably explains its low efficiency in killing aphid eggs when compared with the recommended winter strength of concentrated liquid lime-sulfur. The soluble character of the dry lime-sulfur is undoubtedly important for the superior efficiency of the higher soluble dust form over the lower soluble coarse form is clearly illustrated in Chart II, lines e, f, and g (e = coarse lime-sulfur, 15 lbs. to 50 gals.; f = coarse dry lime-sulfur, 20 lbs. to 50 gals.; g = dust form dry lime-sulfur, 15 lbs. to 50 gals.). Lines f and g approximately coincide and are considerably above line e. This indicates that 20 pounds to 50 gallons of the coarse dry lime-sulfur nearly equals the killing efficiency of 15 pounds to 50 gallons of the dust form.

A few dusting experiments (eggs of *A. avenæ* on March 7, 1919) were tried with dry lime-sulfur (dust form) alone, hydrated lime alone and a combination of one part dry lime-sulfur and one part hydrated lime. The twigs were thoroughly covered and then placed out-of-doors (as in other experiments). The eggs coated with dry lime-sulfur showed a 28 per cent hatch; with hydrated lime, a 48 per cent hatch, and with a combination of dry lime-sulfur and hydrated lime, a 30 per cent hatch. The results of these few dusting experiments indicate that the efficiency of dry lime-sulfur applied as a dust is considerably less than when the dry lime-sulfur (dust form, 15 pounds to 50 gallons) is applied as a liquid spray.

Barium sulfur, largely barium tetra sulphide, commercially known as "B. T. S." was given the same liquid spray tests as dry lime-sulfur (Tables I and II and Charts II, III and V). Where "B. T. S." was used at the rate of 15 pounds to 50 gallons, the killing or efficiency (eggs of *A. avenæ*) is somewhat superior to that of coarse dry lime-sulfur at the same strength, but is decidedly inferior to concentrated liquid lime-sulfur, 1–9 (Charts II and V, line h). "B. T. S." 20 pounds to 50 gallons comes nearer being equal to concentrated liquid lime-sulfur. "B. T. S." is highly soluble in water, 98.1 per cent at the recommended winter strength of 14 pounds to 50 gallons of water. The sulfur content per gallon of the recommended dormant spray of "B. T. S." as it goes on the tree is approximately 50 per cent that of concentrated liquid lime-sulfur, 1–9.

Sodium-sulfur, largely sodium polysulphide, commercially known as "Soluble Sulphur," was experimented with at the rate of 15 pounds to 50 gallons of water. This dry substitute for concentrated lime-sulfur proved to be the most efficient in killing the eggs of *A. avenæ*, yet in no instance did it equal that of concentrated liquid lime-sulfur," 1–9 except on March 21, 1919, when its efficiency was approximately the same (Chart II and V, line i). "Soluble Sulphur" is very caustic and also highly soluble (98.5 per cent soluble) at the rate of 14 pounds to 50 gallons of water. A quantative analysis of the recommended dormant strength of "soluble sulfur" as it goes on the tree shows approximately 50 per cent as much sulfur per gallon as concentrated liquid lime-sulfur, 1–9.

Nicotine

In all the spraying experiments with the eggs of *A. avenæ* and *A. pomi*, the addition of nicotine always increased the killing efficiency of every spray. This is particularly true when nicotine,1–500 was added to concentrated liquid lime-sulfur, 1–6 or 1–9 (j, k, l and m, Chart III), to dry (coarse or dust form) lime-sulfur, 10, 15 or 20 pounds to 50 gallons (n and o, Chart III), to barium-sulfur ("B. T. S."), 10, 15 and 20 pounds to 50 gallons (p, Chart III), and to sodium-sulfur ("Soluble sulphur"), 15 pounds to 50 gallons (q, Chart III). Chart III shows the results of a series of experiments with one or more strengths of each of the above substances plus nicotine, 1–500. Comparing Chart II with Chart III spray lines a=j, b=k, c=l, d=m, e=n, g=o, h=p, and i=q, except for the addition of nicotine 1–500 in j, k, l, m, n, o, p, and q. All of the experiments seen on Chart III show a percentage of kill running between 97 and 100 per cent when the combined spray is applied on March 1, March 10, and March 21. On these same dates all of the concentrated liquid lime-sulfur sprays

1–6 or 1–9 (with and without casein-lime) combined with nicotine 1–500 show 100 per cent kill except one application of lime-sulfur 1–9 plus nicotine, 1–500 (j) made on March 10 (99 per cent kill). Chart V, where the eggs of *A. pomi* were used in all the experiments, also shows an increase in the efficiency of a combined spray of lime-sulfur and nicotine over lime-sulfur alone (a, b, j, and k, Chart 5).

Nicotine added to fish-oil soap also increased its efficiency (Exp. 33, 34, 35, Table I and Expt. 16-p, 17-p, 18-p, Table II or Charts I, IV and V). A combination of fish-oil soap, 1 gm.–50 cc. and nicotine, 1–500 kills 99 per cent of the eggs of *A. avenæ*, when applied on March 21, but earlier applications of the same spray are decidedly inefficient. Nicotine was also added to "Scalecide" 1–15, 1–25 and 1–40 in a few experiments on March 18 (not shown in tables) and the efficiency of the spray was increased 20 to 30 per cent, but in no case was there a complete kill. The best combination proved to be "Scalecide," 1–15 plus nicotine, 1–500 which killed 98 per cent of the eggs of *A. avenæ*. Nicotine was also added to varying strengths of linseed and cotton-seed oil emulsions (2 cc.–8 cc. to 98 cc.–92 cc. respectively, plus laundry soap 1 gm.–100 cc.) but with both oils a reaction occurred which caused the two oils to form large globules that came to the surface at once. This was probably due to the fact that the oil solutions gave an acid reaction. This material was difficult to spray and the efficiency of the combined spray was only increased slightly (Expts. not recorded in table). Nicotine, 1–500 added to sodium sulfo-carbonate 1–9 gave almost complete control (99.7 and 100 per cent) when sprayed on March 18 and March 21 on the eggs of *A. avenæ* and *A. pomi* (see Tables I and II). It is probable that this substance may prove to be as efficient as concentrated liquid lime-sulfur, 1–9 in killing the eggs of *A. avenæ*, however, its effect upon plants particularly green swollen buds is unknown. A few experiments at the laboratory indicate that it would be unsafe to use the above strength on green tissue.

Other Sprays and Chemicals

In addition to the foregoing experiments a large number were conducted, particularly on the eggs of *A. avenæ*, with varying strengths of sodium sulfo-carbonate, hydrated lime, "Scalecide," crude carbolic acid and cresols, fish-oil soap, linseed oil emulsions and cotton-seed emulsions. Some of the more important of these may be found in Tables I and II and on Charts I, IV, and V, but the results of a large number of them are not included in the tables or on the charts in this paper. Each substance will be discussed separately and the significant points brought out.

Sodium sulfo-carbonate chemically known by the formula Na^2CS^3 and also called sodium thiocarbonate was manufactured for Dr. T. J. Headlee three years ago by the Dow Chemical Co., Midland, Mich. The material was tightly sealed in bottles and had partially crystalized when used this season, but the application of a small amount of heat soon melted the crystals. In a few experiments (Expt. 13, 14, 15, 20, Table I and Expt. 8-p, 15-p, Table I, etc.) performed on March 18 and 21 with the eggs of *A. avenæ* and *A. pomi* a 1–9 dilution killed 98 to 100 per cent, a 1–14 dilution killed 79 to 99 per cent, and a 1–19 dilution killed 93 per cent. In a similar lot of experiments ordinary laundry soap (1 gm.–200 cc.) was added with no apparent change in the solution and the percentages of kill with the various strengths (1–9, 1–14, and 1–19) were almost identical with the experiments where no soap was used. Fish-oil soap at varying strengths (1 gm.–50 cc., 1 gm.–100 cc. and 1 gm.–200 cc.) was used with each of the three dilutions (1–9, 1–14, and 1–19) of sodium sulfo-carbonate and in every case the percentage of kill was materially reduced rather than increased as we would expect. Some change probably takes place in the solution when the fish-oil soap is added and this lowers its efficiency. A slight precipitate was formed when a strong solution of fish-oil soap (1 gm.–50 cc.) was used. The above experiments with sodium sulfo-carbonate indicate that it is very efficient in killing aphid eggs. It is worthy of further investigation.

Hydrated lime in a finely divided state was applied in a liquid spray throughout the season on the eggs of *A. avenæ* (Expt. 29, 30, 31, and 32, Table I) in two strengths (1.75 gm.–50 cc. and 3.5 gm.–50 cc.) with and without the addition of casein-lime (lactic). In no experiment with lime by itself did the percentage of kill run over 81 per cent and in most cases it was far below this point. Where casein-lime was added there was a slight increase in the percentage of kill. This is probably due to the fact that the particles of lime become more evenly distributed if casein is present. The addition of casein-lime made a decided increase in the length of time the lime would remain in suspension. Ordinary hydrated lime mixed with water settles immediately unless constantly agitated. Hydrated lime was dusted onto the eggs of *A. avenæ* on March 7, 1919, and 48 per cent of the eggs hatched.

"Scalecide," a miscible oil, was given another thorough tryout this season and again the results clearly demonstrate that such an oil at the recommended winter strength, 1–15 does not kill a sufficient quantity of eggs to make it a practical spray for the control of aphis in the egg stage. The greatest percentage of kill was 91 per cent with *A. avenæ* and 88 per cent with *A. pomi* when the eggs were sprayed on

March 21. Other applications at the same strength applied earlier in March and throughout the season show a much lower percentage of kill, some as low as 48 per cent (Expts. 38, 39 and 40, Table I, Expt. 21-p, 22-p and 23-p, Table II). Three years of careful study at the laboratory and in the orchard convinces us that this miscible oil is not an efficient agent for killing eggs of plant lice occurring on apple trees.

Crude carbolic acid and various cresols used in different experiments in 1917–1918 were again used during the past season on the eggs of *A. avenæ* and some on the eggs of *A. pomi*. A 2 per cent solution of crude carbolic acid (Expt. 36, and 37, Table I and Expt. 19-p, 20-p, Table II) was applied on the eggs of *A. avenæ* and *A. pomi* at regular intervals. The percentage of kill was not very great in any application except on March 21 when the acid killed 90 per cent of the eggs of *A. avenae* and 85 per cent of the eggs of *A. pomi*. Altogether this season's results with crude carbolic acid show a smaller percentage of kill than in 1918. Crude carbolic acid (2 gm.–98 cc.) was also combined with fish-oil soap (paste form) 1 gm.–50 cc. and sprayed on the eggs of *A. avenæ* at regular intervals. This combination killed the greatest percentage of eggs on March 21, 97.2 per cent of *A. avenæ* and 87 per cent of *A. pomi*. All applications of this combination before March 21 permitted 22 to 58 per cent of the eggs to hatch. The addition of fish-oil soap helps materially to increase the efficiency of the carbolic acid mixture, yet the results are by no means sufficiently satisfactory for practical use in orchard spraying. It is also probable that a 2 per cent solution of crude carbolic would injure green swollen fruit buds, if one waited until the eggs were most susceptible to sprays. On March 7, 1919, a large number of experiments were conducted on the eggs of *A. avenæ* with 1 and 2 per cent solutions of crude carbolic acid, cresol U. S. P., phenol c. p., ortho cresol c. p., meta cresol c. p., and para cresol c. p. and the results were similar to those of 1917–1918. Crude carbolic acid was somewhat superior to all. No spray killed over 60 per cent of the eggs.

Fish-oil soap at the rate of 1 gm.–50 cc. of water was sprayed on the eggs of *A. avenæ* on February 10, March 1, March 10 and March 21, and the greatest kill, 85 per cent, took place on March 21. The same strength was sprayed on the eggs of *A. pomi* on March 21, 1919, and it killed 92 per cent. The percentage of kill of the eggs of *A. avenæ* with this same strength of soap and applied previous to March 21 was 36 to 52 per cent. Fish-oil soap at different strengths was also combined with various sprays (discussed under separate sprays).

Linseed and cotton-seed oil at strengths varying from 2 to 8 per cent of the solution were thoroughly emulsified with laundry soap

and fish-oil soap (1 gm.–200 cc., 1 gm.–100 cc. and 1 gm.–50 cc.) and given a thorough tryout. A series of interesting results were obtained, but none of these gave a satisfactory control. In most instances linseed oil at a given strength was somewhat more efficient in killing eggs than cotton-seed oil. The greatest strength used gave the highest percentage of kill. Where linseed oil (Expt. 41, Table I; Expt. 24-p, Table II) was used at the rate of 8 cc.–92 cc. of soap solution (laundry soap, 1 gm.–100 cc.) it killed 94 per cent of the eggs of *A. avenæ* and 91 per cent of *A. pomi* when applied on March 21. Where applications were made on March 10 or previous to this the greatest percentage of kill was 64 per cent or less. Where cotton-seed oil was used at the rate of 8 cc. to 92 cc. of soap solution (laundry soap 1gm.–100 cc.) it killed 92 per cent of the eggs of *A. avenæ* and 90 per cent of the eggs of *A. pomi* when applied on March 21. Where applications were made on March 10 or before the percentage of kill was 54 per cent or less. Crude carbolic acid at the rate of 1 gm. to 100 cc. of spray was added to linseed and cotton-seed oil sprays and in the majority of cases there was a slight reduction in the percentage of hatch over the same strength of oil emulsion alone. Fish-oil soap at various strengths was used to emulsify the linseed and cotton-seed oils. Where fish-oil soap was used at the rate of 1 gm.–50 cc. with a given strength of oil the greatest reduction usually occurred. More than likely one could kill 100 per cent of the eggs by using a strong fish-oil soap and at least 8 cc. to 92 cc. of linseed or cotton-seed oil and applying the same near the hatching period. The principal objection to such a combination would be its high cost.

Conclusions

The following statements concerning the structure, behavior and response of the eggs of *A. avenæ* and *A. pomi* (and probably *A. sorbi*) to environmental factors and various sprays are based on three years of study.

The eggs are covered with two distinct layers, an outer semi-transparent hardened shell and an inner pigmented (black) soft membrane. The outer shell is much more impervious to water than the inner black membrane (chorion). The outer shell splits (usually) along the dorsomesal line a short time (in some cases over 30 days) before the inner pigmented membrane is severed by the nymph. Evaporating factors apparently influence the rapidity of the splitting of the outer layer. Low evaporation seems to delay the splitting, while high evaporation probably has the opposite effect. Evaporating factors also influence the percentage of hatch, particularly at the time when the eggs are splitting their outer shells. Incubator and other experiments where

moisture and temperature were controlled and also out-of-door observations during variable seasons show that high evaporating factors during the most susceptible period of the egg (10 to 15 days before hatching) decreases the percentage of hatched eggs while low evaporating factors during the same period increases the percentages of hatch.

The eggs are not only most susceptible to evaporating factors when many of the eggs are splitting their outer shells, but they are most easily killed by various contact sprays applied at this time. Experiments with a large number of contact sprays at their recommended winter strength shows conclusively that concentrated liquid lime-sulfur, 1–9 is the most efficient. The lower efficiency of recommended winter strengths of dry lime-sulfur and substitutes is probably in part due to the lower sulfur content of each. The insoluble character of dry lime-sulfur is also important in accounting for its inefficiency.

Nicotine added to any spray increases its efficiency in killing the eggs of *A. avenæ* and *A. pomi*. This was particularly true where nicotine, 1–500 is added to the recommended dormant strengths of concentrated liquid lime-sulfur, dry lime-sulfur and substitutes ("B. T. S." and "Soluble Sulphur").

Sodium sulfo-carbonate, 1–9 or 1–14 kills a large percentage of eggs and is worthy of further investigation. Various sprays made with hydrated lime, strong fish-oil soap solutions, miscible oil ("Scalecide," 1–15 to 1–40), crude carbolic acid, cresols, linseed and cotton-seed oil emulsions, etc., only kill a small percentage of eggs during December, January, February and the early part of March. Some of these sprays kill 80 to 95 per cent of the eggs if applied when the fruit buds first show green (March 21, 1919).

The New Jersey Agricultural Experiment Station is recommending a delayed dormant spray of concentrated liquid lime-sulfur, 1–9, combined with nicotine (Black Leaf 40), 1–500. This spray should be applied when the fruit bud is swollen and first shows green. Applications made after the leaves are out one half inch or more will burn the foliage of most varieties.

Key to Plotted Experiments on Charts Taken from Tables I and II. Similar Treatment Represented by Same Letter in all Charts. All 1918-1919 Experiments Except Chart I.

Expts. Plotted Table I (*A. avenæ*)	Expts. Plotted Table II (*A. pomi*)	Letters on Charts	Sprays
1*	1-p	a	Liquid lime-sulfur, 1–9
2	2-p	b	Liquid-sulfur, 1–6
3		c	Liquid lime-sulfur, 1–9 plus casein-lime, 1 gm.–100 cc.
4		d	Liquid lime-sulfur, 1–6 plus casein-lime, 1 gm.–100 cc.
6	4-p	e	Dry lime-sulfur (S-W), 15 lb.–50 gal.
7		f	Dry lime-sulfur (S-W), 20 lb.–50 gal.
8		g	Dry (dust form) lime-sulfur, (S-W), 15 lb.–50 gal.
10	6-p	h	"B. T. S.," 15 lb.–50 gal.
12	7-p	i	"Soluble-sulphur," 15 lb.–50 gal.
16*	9-p	j	Liquid lime-sulfur, 1–9 plus nicotine, 1–500
17	10-p	k	Liquid lime-sulfur, 1–6 plus nicotine, 1–500
18		l	Liquid lime-sulfur, 1–9 plus casein-lime, 1 gm.–100 cc. plus nicotine, 1–500
19		m	Liquid lime-sulfur, 1–6 plus casein-lime, 1 gm.–100 cc. plus nicotine, 1–500
21		n	Dry lime-sulfur (S-W), 15 lb.–50 gal. plus nicotine, 1–500
23		o	Dry (dust form) lime-sulfur (S-W), 15 lb.–50 gal. plus nicotine, 1–500
25		p	"B. T. S.," 15 lb.–50 gal. plus nicotine, 1–500
27		q	"Soluble sulphur," 15 lb.–50 gal. plus nicotine, 1–500
29		r	Hydrated lime, 1.75 gm.–50 cc.
32		s	Hydrated lime, 3.5 gm.–50 cc. plus casein-lime, 0.5 gm.–50 cc.
38*	21-p	t	"Scalecide," 1–15
33*		u	Fish-oil soap, 1 gm.–50 cc.
34*		v	Fish-oil soap, 1 gm.–50 cc. plus nicotine, 1–500
*	18-p	w	Fish-oil soap, 1 gm.–100 cc. plus nicotine, 1–500
36		x	Fish-oil soap, 1 gm.–50 cc. plus crude carbolic acid, 1 cc.–99 cc.
41		y	Fish-oil soap, 1 gm.–50 cc. plus crude carbolic acid, 2 cc.–98 cc.
43		z	Linseed oil, 8 cc.–92 cc. plus laundry soap, 1 gm.–100 cc.
		z-2	Cotton-seed oil, 8 cc.–92 cc. plus laundry soap, 1 gm.–100 cc.

* Similar experiments with eggs of *A. avenæ* for season of 1917–18. See chart I.

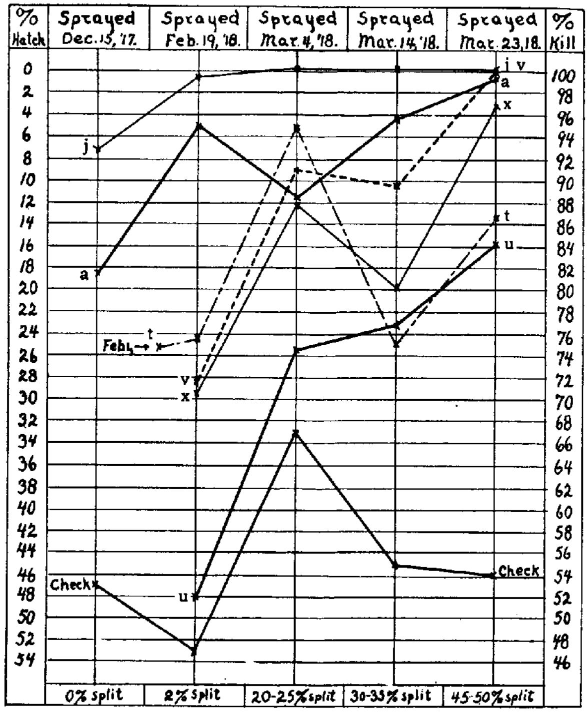


Chart I. Plotted lines showing the ovicidal value of several sprays on the eggs of *A. avenae* for the season of 1917–1918. These sprays are similar to some plotted on charts II, III, IV and V for 1918–1919.

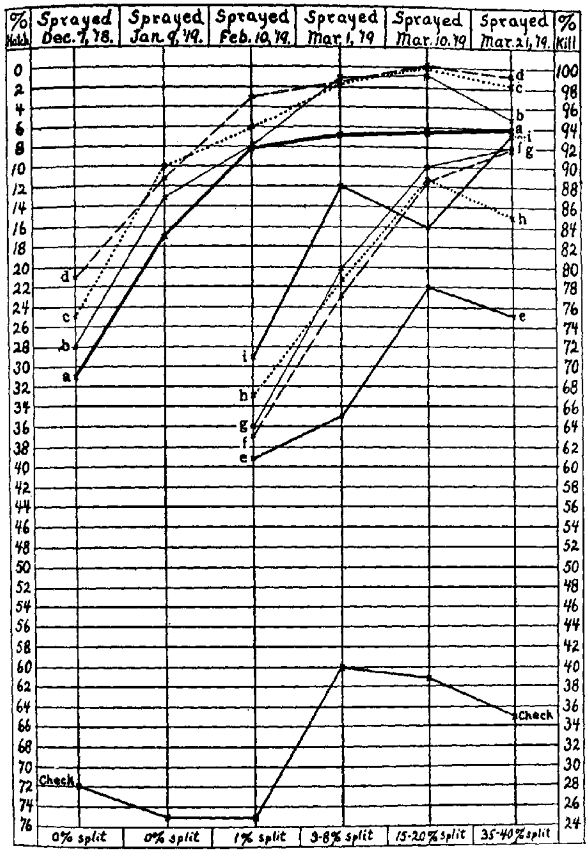


Chart II. Plotted lines showing superiority of concentrated liquid lime-sulfur, 1-9 and 1-6, over dry substitutes, 15 pounds to 50 gallons of water (dry lime sulfur (S-W), "B.T.S." and "Soluble sulfur") in killing the eggs of *A. avenae*. 1918–1919.

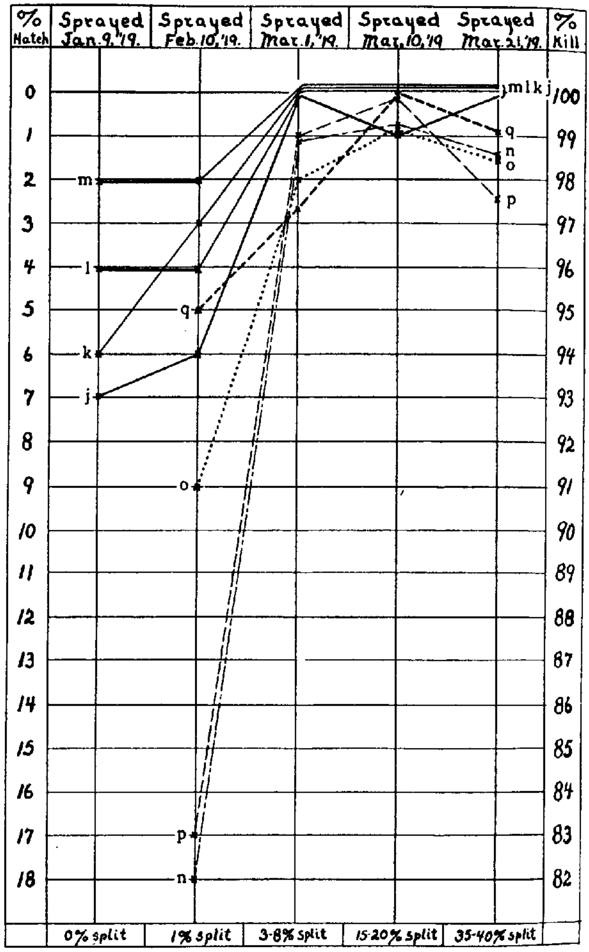


Chart III. Plotted lines showing results of experiments similar to those in chart II (same sprays and same strength) except for the addition of nicotine, 1-500 to each spray. Observe the decided increase in kill of the eggs of *A. avenae*, 97-100 per cent, when the various sprays were applied during March 1918–1919.

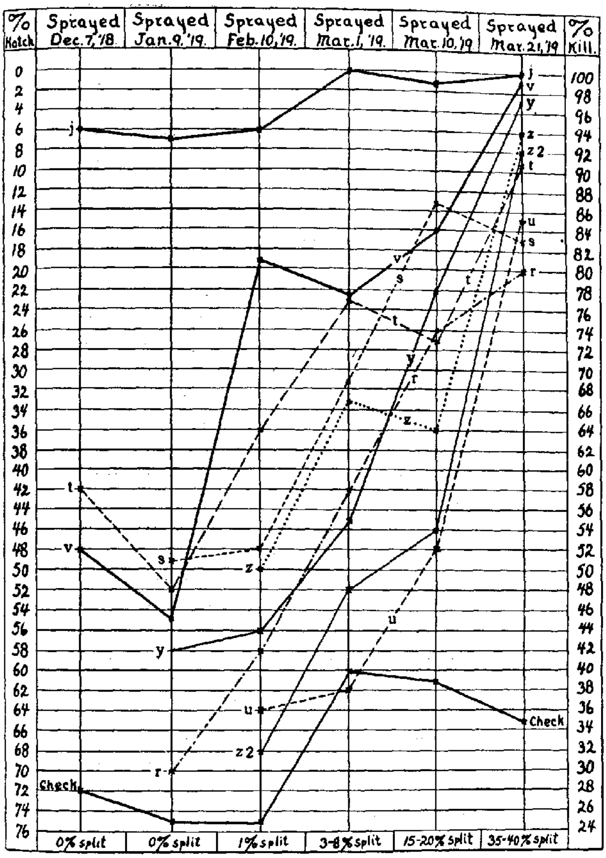


Chart IV. Plotted lines showing the superiority of recommended liquid lime-sulfur, 1-9 plus nicotine, 1-500 spray over other sprays ("Scalecide," hydrated lime, fish oil soap, fish oil soap combined with nicotine and with crude carbolic acid, linseed oil emulsion and cottonseed oil emulsion) in killing the eggs of *A. avenae*. Observe the decided increase in the killing effect of each spray when applied nearer the hatching period (or as the susceptibility of the eggs increases). 1918-1919.

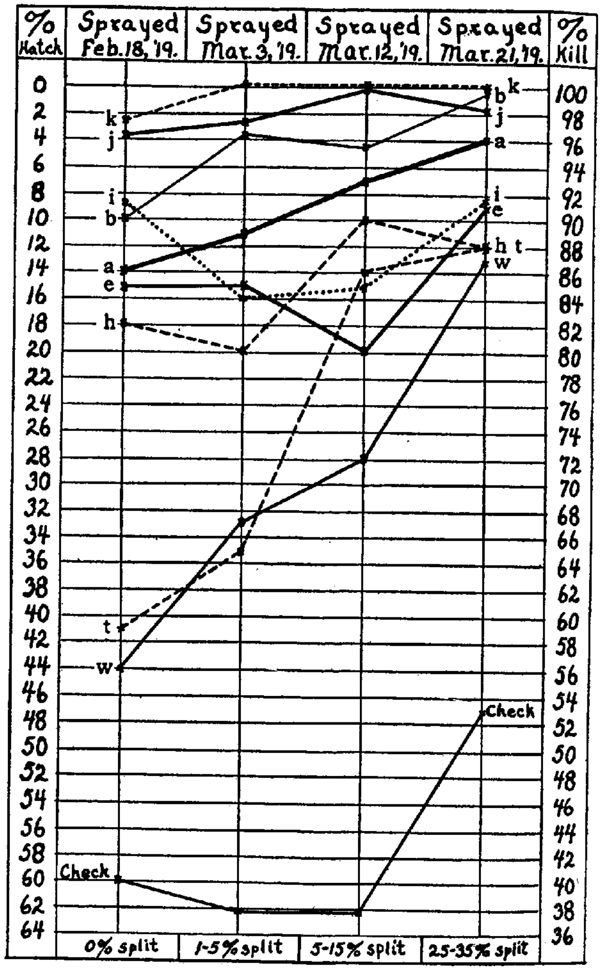
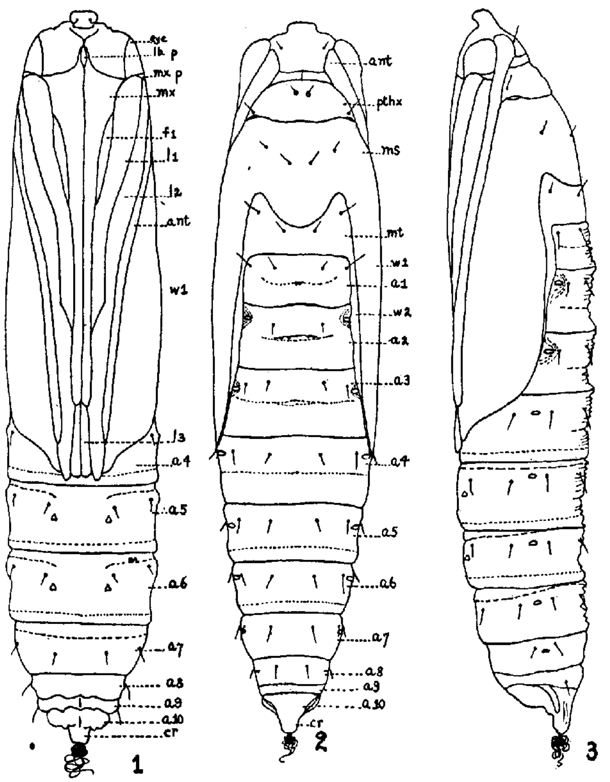


Chart V. Plotted lines showing the ovicidal value of several sprays on the eggs of *A. pomi*. 1918–1919.

NOTES ON THE PUPÆ OF THE EUROPEAN CORN BORER, PYRAUSTA NUBILALIS AND THE CLOSELY RELATED SPECIES P. PENITALIS

By Edna Mosher

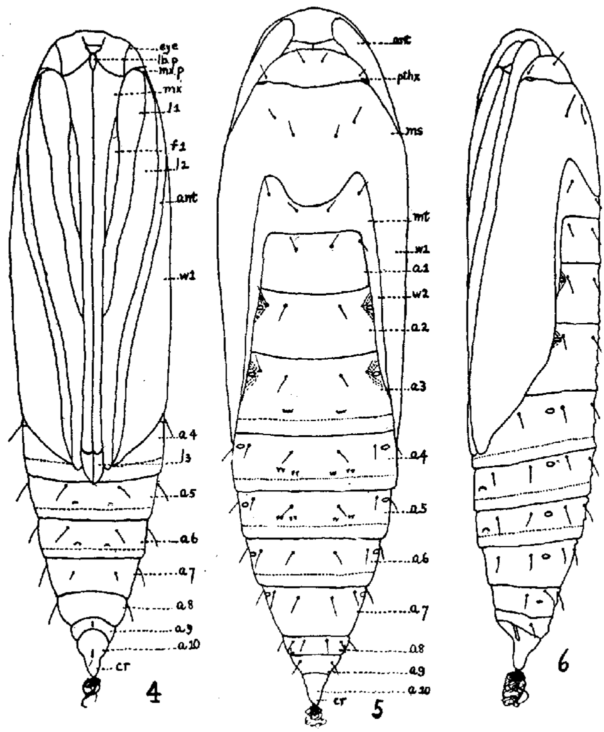
Since the larvæ of these two species of Pyrausta are so closely related, it is interesting to find that the pupæ are much more easily distinguished than the larvæ. The element of doubt which one may have



Pyrausta penitalis.—Fig. 18; 1 ventral view; *lb. p.*, labial palpi; *mx. p.*, maxillary palpi; *mx.*, maxillæ; *f* 1, femur of prothoracic leg; *l*1, *l*2, *l*3, legs; *ant.*, antennæ; *w*.1, *w*.2, wings; *pthx*, *ms*, *mt.*, thoracic segments; *a*1 to *a*10, abdominal segments; *cr.*, cremaster; 2, dorsal view; 3, lateral view.

in trying to identify the larva is entirely eliminated when these insects reach the pupal stage.

As in the larvæ, the pupæ of *P. nubilalis* are slightly longer and stouter than those of *P. penitalis*. The average length of the male pupa of *nubilalis*, when retracted is 13 mm., while that of *penitalis* is



Pyrausta nubilalis.—Fig. 19, 4, ventral view; 5, dorsal view; 6, lateral view. (Abbreviations as in *P. penitalis*.)

11 mm. The females average respectively 15 and 13 mm. Both species are yellow when young, tinged with brown on the head and cremaster. When older, especially in *nubilalis*, the dorsal surface becomes quite brown.

The main differences in the pupae may be easily seen in the figures. Perhaps the most striking is the blunt projection on the head of *penitalis*. In the ventral views (Figs. 18, 19, 1 and 4) it will be noticed

that the maxillæ (mx.) and the antennæ (ant.) are considerably shorter in *penitalis*, and that the comparative length and breadth, as well as the shape of abdominal segments eight to ten varies considerably.

In the dorsal views (Figs. 18, 19, 2 and 5) it will be noticed that the head projects considerably cephalo-laterad of the antennæ in *penitalis*, while this projection is very slight in *nubilalis*. The dorsal surface of the abdomen is considerably wrinkled in *penitalis* and the first segments show rather deep furrows near the middle of the segment as indicated by dotted lines in the figure. On the first segment there are two small teeth on the cephalic side of the furrow, one on each side of the median line. On the second segment there are two or three teeth on each side, a little farther laterad than on the first. The furrow on the third segment is narrower and shows no teeth. The setæ on *penitalis* mostly arise from small projections, which are not quite so prominent in *nubilalis*. In *nubilalis* there are no dorsal furrows as described in *penitalis* and the surface is very little wrinkled, though somewhat roughened with minute projections. Near the caudal margin of abdominal segments four to six in *nubilalis* are some small triangular spines, never very distinct, which vary somewhat in number and arrangement. In some individuals there are traces of spines on segments three and seven. The lateral furrow of the tenth segment shows much more distinctly in a dorsal view of *penitalis*.

The lateral views (Figs. 18, 19, 3 and 6) merely emphasize some of the points previously mentioned and show the difference in the size of the lateral furrow of the tenth segment.

Mr. D. J. Caffrey of the European Corn Borer Laboratory in Arlington, Mass., furnished material for the study of *P. nubilalis*, while Mr. George G. Ainslie loaned material of *P. penitalis*, so that I am deeply indebted to both for making this study possible.

AN INJURIOUS LEAF-MINER OF THE HONEYSUCKLE

By C. R. Crosby and M. D. Leonard

In August, 1917, our attention was called by Charles Fowler to a serious outbreak of *Lithocolletes fragilella* Frey and Boll, on Belgica honeysuckle in a nursery at Honeoye Falls, N. Y. The plants growing in the open were badly infested by the miners, nearly every leaf showing one or more mines. In spite of this heavy infestation the injury to these plants was negligible. When, however, cuttings were taken from these plants and placed under glass in the cutting beds the leaves were so badly injured by the miners that the cuttings failed to grow. Several hundred cuttings placed in the beds June 26 were a total loss.

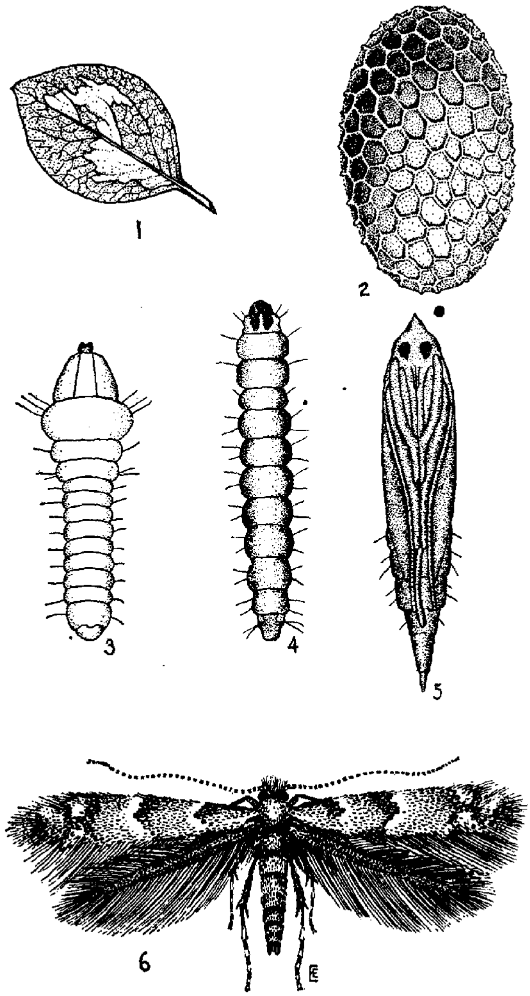


Fig. 20; 1, Mines on underside of leaf; 2, Egg (x 180); 3, First stage larva (x 210); 4, Last stage larva (x 10); 5, Pupa (x 17); 6, Moth (x 15).

A second lot planted July 26 fared the same. In a third lot, planted August 26, the injury soon became apparent. In making these cuttings the greenhouse foreman had been careful not to select cuttings on which mines were apparent but as many eggs were present on the leaves the injury soon appeared. Owing to the great difficulty of growing plants from green cuttings due to the depredations of this insect, this method of propagation has been abandoned at this nursery and hard-wood cuttings have been used instead.

We visited the nursery on August 26 and found moths, eggs, pupæ and all stages of the larvæ present on the plants out of doors. The eggs were deposited singly on the underside of the leaves. The egg (Fig. 20, 1) is oval in outline, flattened on the side of attachment, convex above and pale yellowish in color. The surface is beautifully sculptured with more or less regular hexagonal pits. The measurements of three eggs are as follows: .24 by .18; .26 by .16; and .28 by .2 mm.

The beginning of the mine is indicated by the empty egg shell. The young larva at first forms a linear mine on the underside of the leaf which gradually widens and extends along a vein. After running for about 5 mm. this abruptly enlarges into a blotch which obliterates the linear mine. The blotch mine (Fig. 20, 2) is on the underside of the leaf, is about 10 mm. in diameter and is usually outlined by the larger veins. There is only one larva in a mine but there are often several mines in a leaf.

The recently hatched larva (Fig. 20, 3) measures .44 mm. in length with the prothorax very wide. It is pale translucent or pale greenish from the ingested food with the head slightly brownish. In the next to the last stage the larva is about 2.5 mm. in length, pale yellowish in color, distinctly flattened and the prothorax is twice as wide as the head. The sides of the prothorax project so as to almost form tubercles. The body gradually tapers posteriorly and becomes nearly cylindrical. The head which is .25 mm. wide is slightly less rounded than in the next stage and is held in a nearly horizontal position. The legs are somewhat paler than in the full-grown larva.

The full-grown larva (Fig. 20, 4) is about 5 mm. in length, yellowish and nearly cylindrical with the last four or five segments tapering. The head is dark brown, almost black, with the cervical shield somewhat lighter. The thoracic legs are well developed and brown in color. Only three pairs of prolegs are present besides the usual anal pair, and are situated on the third, fourth and fifth abdominal segments. There is a small black bar between the prothoracic legs.

In the next to the last stage the larva lines the mine with silk and folds the leaf downward, puckering the under surface of the mine into

a series of parallel folds and at the same time somewhat crumpling the upper surface. About the same time it eats out holes in the upper parenchyma around the edges of the mine which show through as a series of pale spots. In the last stage the process is continued and the leaf is frequently folded double. Pupation takes place in a cocoon, elliptical in outline, about 6 mm. long by 4 mm. wide. The cocoon is composed of a single layer of silk and is attached closely to the upper lining of the mine and loosely to the lower.

The pupa (Fig. 20, 5) is 3.5 mm. in length, at first pale yellowish but becoming darker with age. The head ends in a pyramidal point directed downward, without visible serrations. The head, wing, leg and antennal cases are dark brown. The dorsal surface of abdominal segments 2 to 7 is armed on the front half with dark brown spinules and on the posterior quarter with a band of much smaller ones. The first and eighth segments show traces of a similar armature. Segments 4 to 7 are movable. When about to transform the pupa works its way partly out of the mine. In one instance we found a pupa skin projecting half its length through the upper surface of the leaf.

The moth (Fig. 20, 6) has an expanse of 6 to 7 mm. The fore wings are reddish brown with golden reflections in certain lights. Each is crossed by four narrow black bands bordered on the outside with white. The third and fourth bands are connected by a black bar. There is a black dot and a white crescent at the apex. The head is tufted with reddish brown hairs. The antennæ are long and slender and are banded with black and white. The hind wings, abdomen and legs are dark gray, with the tarsi black and white.

In 1873 Frey and Boll (Stett. Ent. Zeit. 34: 215) record rearing moths from mines in the leaves of *Lonicera sempervirens* from Cambridge, Mass., which they with doubt referred to *Lithocolletes trifasciella* Haworth. In 1878 (Ibid 39: 270) they described *L. fragilella* from specimens from Texas reared from mines on the underside of the leaves of *Lonicera albida.* In 1891 Lord Walsingham (Ins. Life 3: 326) stated that he had examined one of the specimens bred by Frey and Boll from *Lonicera sempervirens* from Cambridge and referred by them with doubt to *L. trifasciella* and pronounced it to belong to their *L. fragilella.* Cook (Third Rept. Mich. Agr. Exp. Sta. for 1890: 117) records rearing what appears to be this species from honeysuckle from Gratton, Mich., although he identified it as *L. trifasciella* Stainton and his description of the mine, larva and pupa does not agree with that of *L. fragilella.*

HIBERNATING HABITS OF TWO SPECIES OF LADYBIRDS

By David E. Fink, *Truck-crop Insect Investigations, U. S. Department of Agriculture*

Two species of ladybird beetles have similar hibernating habits in Tidewater, Va., the spotted ladybird (*Megilla maculata* DeG.), and the squash ladybird (*Epilachna borealis* Fab.), the former beneficial, the latter injurious. Both species were studied while the writer was stationed at Norfolk, Va., the former in connection with the ladybird colonization project for that region[1], the latter in its role as a pest on watermelon. It was observed that the beetles of *Megilla maculata* have a habit of congregating during late fall on the trunks of trees in the vicinity of its feeding areas, for concealment in deep crevices or under loose bark of trees as a protection during the winter months. Some speculation was indulged in to account for their repeated return to the same trees year after year, though it was certain, from the knowledge of their life-history, that the progeny of ladybirds that hibernated probably were not related any more closely than the fifth or sixth generation to their ancestors that had occupied the same trees previously.

Habits of Megilla maculata

During late fall, or after repeated heavy frosts, although aphides were still present on spinach, kale and cabbage, the ladybirds left these plants to find shelter elsewhere. In the localities where they had been artificially colonized, they were observed for several years seeking the protection afforded by certain trees growing in the immediate vicinity of farm buildings. They were attracted by different species of trees. In one locality they hibernated every year on pin oak (*Quercus palustris*), in another on hard maple (*Acer saccharum*), and in other places on red mulberry (*Morus rubra*) and red cedar (*Juniperus virginiana*).

When beginning hibernation the beetles do not alight directly on the tree trunks, but gather on the ground about the base of a tree, afterwards crawling up the trunk and seeking suitable cavities or loose bark for shelter. They arrive singly and by twos and a cavity soon harbors several hundred individuals, the size of the colony depending to some extent on the accommodation of the cavity or crevice. On large trees many natural shelters occur, and the ladybirds, discovering these, in due course divide into groups and occupy them. First the cavities on all parts of a tree are occupied, but with colder weather only the south and east exposures become inhabited. At no

[1] Bul. 15, Va. Truck Exp. Sta., Norfolk, Va., Apr. 1, 1915.

time during the winter are the ladybirds entirely dormant. The warm rays of the sun on mild days cause more or less activity among them, either in the form of an oscillating movement within the shelters or a migration along the trunk to other cavities.

Other forms of heat cause activity. An instance of this nature occurred in which a horse left tied close to a tree harboring this ladybird had his abdomen almost completely covered with the beetles in a short time. The heat of the animal had evidently awakened them to activity and, using the rein as a bridge, they had crawled beneath the horse's blanket, much to the animal's chagrin, and he was unable to get rid of them by switching his tail.

Early in spring the beetles leave the trees and scatter in the surrounding fields.

To account for their repeated return to the same trees for successive years several theories were considered. One theory was that as ladybirds are known to emit a strong odor, the trees become impregnated to such a degree as to serve as an attraction to future generations. Although no such odor could be detected at any time it was thought possible that our limited olfactory senses failed to detect what was perhaps quite keen to the insects. Nevertheless the cavities remain unoccupied for at least eight months of the year, during which time the tree is constantly exposed to the elements; besides, the odor must be penetrating to attract the insects from a considerable distance.

Afterwards, the natural odor from the tree was considered as a possible attraction, yet the variety of trees which they frequent together with the fact that they also hibernate between boards along fences and among piled stakes, precludes the serious consideration of this theory. Experiments were made by confining slabs of bark of oak, maple, cedar and mulberry in cheesecloth cages and liberating ladybirds in them to determine whether or not the odor of the bark would attract them. In every instance the beetles entirely ignored the bark, preferring to hide in the crevices made by the cloth and supporting posts.

The possibility of an inherited instinct of attraction to trees was also considered as a plausible factor. The fact that the beetles return to the same trees year after year, however, and the further fact that some individuals hibernate on material other than trees, necessitates the abandonment of this theory also.

Finally, the conclusion was reached that frequent hibernation on the same trees is purely accidental, or merely a matter of convenience, being confined to those beetles in the immediate vicinity and to accidental individuals from among those hibernating on other material.

The process by which the species manages to assemble on the same

Megilla maculata hibernating on pin oak (*Quercus palustris*).
The arrows point to two colonies.

Megilla maculata hibernating on pin oak (*Quercus palustris*).
A reduced view of one colony.

trees every year is as follows: *Megilla maculata* feeds almost entirely on aphides which occur on various crops in near-by fields. As cold weather approaches the aphides breed in larger numbers on crops that are more or less protected, as in fields nearest buildings or trees. Such places are also more favorable to a longer activity of the beetles. The tendency, therefore, is for the ladybirds gradually to drift from outlying portions of a field to places near the protected parts where food is more abundant. In any given locality the conditions are the same year after year, so that at the end of the growing season the majority of the beetles are in the neighborhood of trees that are excellently adapted for the purpose of tiding them over the winter months, irrespective of the fact that these same trees were used the previous year for the same purpose by the ladybirds' predecessors.

Habits of Epilachna borealis

The squash ladybird possesses the same habit of seeking trees for protection during the winter, although it undoubtedly hibernates in other places. Beetles of this species, however, do not always return to the same trees, as is the case with *Megilla maculata*, because their main food plants are often shifted from one locality to another. Rotation is a very common and successful practice in watermelon culture, the same field not being used a second time for this crop until the lapse of four or more years. In other respects the hibernation habits of these two species are identical; indeed, in the watermelon regions of Virginia the two species are commonly found hibernating together.

The fact that they do not inhabit the same trees every season was determined as follows: In one locality they hibernated on hickory (*Hicoria glabra*). The following year they were observed on two large persimmons (*Diospyros virginiana*) growing in the center of a watermelon field, and other individuals were found on pines bordering the same field, but none of the ladybirds occurred on the hickory tree that they used the previous season, although the fields were only 500 feet apart. In another locality the ladybirds were observed one season hibernating in old apple trees on the border of a watermelon field. The following year they hibernated on a row of red cedar (*Juniperus virginiana*), and none were found on the apple trees.

The habit of this species of seeking winter quarters according to convenience seems to confirm the conclusion drawn with respect to the accidental return of *Megilla maculata* to the same trees. Both species are guided in their choices by their feeding habits. With the former the conditions are more or less fixed, while with the latter crop rotation involving the insect's food plant causes the beetles to migrate from field to field.

XANTHONIA VILLOSULA MELSH. INJURING FOREST TREES

(Coleoptera, Chrysomelidæ)

By WALTER H. WELLHOUSE, *Cornell University, Ithaca, N. Y.*

During the summer of 1918 a number of different forest trees about Ithaca were injured by small brown leaf beetles. They were determined as *Xanthonia villosula* Melsh. by Mr. Charles W. Leng. The writer first noticed them feeding on the leaves of Cratægus on June 27, the leaves on a few small trees being almost completely riddled by them. A few days later they were seen feeding on other trees in a woodlot near Cornell University and soon they were found to be quite generally distributed in wooded areas about Ithaca. Small trees with foliage near the ground were often found to be nearly defoliated and occasionally a large tree had most of its leaves perforated with their feeding holes.

This insect was described by Dr. F. E. Melsheimer in 1847. It was reported by Mr. J. Stauffer of Lancaster, Pa., as "committing heavy depredations" on grape-vines in July, 1865. The injury was probably only local since there seems to be no other account of it. The beetles have been taken by collectors and recorded in systematic papers quite often, but its life-history and habits seem to be unknown. Dr. J. B. Smith stated that it is common in New Jersey on oak and hazel. Mr. Chittenden found it on leaves of hickory. Mr. W. S. Blatchley says it was beaten from hazel and oak in Indiana.

The hornbeam (*Carpinus caroliniana* Walt.) and the ironwood trees (*Ostrya virginiana* Willd.) seemed to be most frequently attacked last summer, but the writer found it also feeding on the leaves of *Cratægus punctata*, shag-bark hickory (*Carya ovata*), hard maple (*Acer saccharum*), linden (*Tilia americana*), white oak (*Quercus alba*), wild grape (*Vitis riparia*), wild blackberry (*Rubus* sp.), witch hazel (*Hamamelis virginiana*), wild rose, *Waldstenia fragarioides*, and wild strawberry (*Fragaria virginiana*).

The adults were found feeding on the leaves from June 27 until August 2 at Ithaca. Their feeding habit is quite characteristic. They cut a chain of small holes close together on the leaf, leaving only a thin cross bar of leaf tissue between the holes. The hole which forms each link in the chain is seldom more than one millimeter in diameter. The beetles drop quickly to the ground when disturbed and are readily beaten down into a net. They vary in color from brown to black, some being entirely brown, some black and a few are part brown and part black. The writer has found brown ones and black ones mating

together and two of the same color mating. These two color forms have been known as separate varieties, *stevensi* Baly and *plagiatus* Melsh. They mated and deposited eggs during the last half of July.

The eggs were laid in moist earth just below the surface of the ground. One mass was found to contain nineteen eggs glued together with a viscous covering. The egg is elliptical in form, is 0.65 mm. long and 0.3 mm. broad at the middle. It is smooth and a glistening white in color.

The larvæ have not yet been found but probably live in the ground and feed upon the roots of plants.

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NAPHTHALENE VS. CHICKEN LICE[1]

By W. S. Abbott, *Bureau of Entomology*

In connection with the work of testing proprietary insecticides and their ingredients, which is carried on at the Insecticide Board's Testing Laboratory located at Vienna, Va., a considerable amount of data has been obtained on the value of naphthalene as a chicken lice remedy. These experiments have been summarized, and since much of this data is new they are presented here in the hope that they may be of value to economic entomologists who are interested in this line of work.

Naphthalene is a very common ingredient in proprietary lice powders, occurring in those tested in quantities ranging from .17 per cent to 67 per cent. It is also found on the market moulded into the form of nest eggs which may be pure naphthalene or naphthalene mixed with paraffin, clay, plaster, etc.

The hens used in these tests were of no particular breed or age, and were all moderately to badly infested with chicken lice of several species. The common body louse, *Menopon biseriatum* Paiget, was the most abundant, but *M. pallidum* Nit., *Lipeurus heterographus* Nit., and *Goniocotes abdominalis* Paig., were often present.

[1]Published with the consent of the Secretary of the U. S. Department of Agriculture.

Naphthalene was tested in three ways:

1. As a dust in various percentages.

2. Sprinkled over the backs of the fowls while they were on the roost at night.

3. In the form of nest eggs.

Naphthalene as a Dust

In these experiments the chickens were held by one person and dusted by another. The powders were applied by means of a hand dust gun or shaker and, unless otherwise noted, were well rubbed into the feathers. The fowls were confined in cages or small chicken houses and were carefully examined one or two days after treatment when the percentage of lice killed or repelled was estimated. Various finely powdered materials, such as lime, charcoal or flour were used on carriers, it having been proved that these materials were not effective against lice.

Table No. 1 gives the results of these dusting tests.

Table I. The Results of Tests with Naphthalene Used as a Dust Against Chicken Lice

Test No.	Per Cent Naphthalene	Inert Carrier	Number of Hens Dusted	Duration of Test	Per Cent of Lice Killed or Repelled	Remarks
1	1.5	Lime	2	2 days	5–10	
2	5.0	Flour	3	1 day	10	
3	10.0	"	6	"	90–95	All sick but soon recovered
4	15.0	"	5	"	95–98	do
5	20.0	"	4	"	95–100	do
6	60.0	Charcoal	4	"	100	Not rubbed in; hens sick but recovered
7	"	"	4	"	100	Rubbed in; hens killed
8	100.0	None	1	15 hours	100	do
9	"	"	1	1 day	100	Not rubbed in; hens sick but recovered

These data show that a powder containing 5 per cent or less of naphthalene is of no value against chicken lice, while 10 per cent or more is very effective.

In all cases where 10 per cent or more of naphthalene was used and well rubbed into the feathers, the fowls were slightly injured. The lower percentages seemed to partially stupefy the fowls and to temporarily deprive them of the free use of their legs. They would slump down on the ground with their eyes closed and frequently fall over on one side. When aroused they would run about and then settle down as before. These symptoms would last for five or ten minutes and then recovery seemed to be complete, as no ill effects were noticed after this. It is apparent, however, that until the exact character and the amount of this injury has been accurately determined, powders

containing more than 10 per cent of naphthalene should be applied with considerable caution.

Birds that were dusted with 60 per cent or 100 per cent naphthalene were killed when the powder was thoroughly rubbed into the feathers, but were not permanently injured when lightly dusted.

Naphthalene Sprinkled over the Fowls While at Roost

Since a method of controlling chicken lice which did not necessitate catching and treating each bird individually would be of great value to the poultryman, a series of tests was made to determine the effects of treating the fowls while they were on the roost. In these tests finely powdered naphthalene was sifted or sprinkled over the backs of lousy hens after they had settled down on the roost at night, care being taken to disturb them as little as possible. Tests 1 to 3 were made in cages in the greenhouse and Tests 4 to 9 in small hen houses.

Table II gives the results of these tests.

Table II. The Results of Sprinkling Naphthalene over the Backs of Lousy Hens While They were on the Roost at Night

Test No.	Number of Hens Dusted	Per Cent of Naphthalene	Per Cent of Lice Killed or Repelled	Temperature		Remarks
				Max.	Min.	
1	2	60	95	..	..	
2	2	60	98–99	..	..	
3	2	100	98–100	..	..	
4	5	"	80	80°	66°	
5	5	"	0–80[1]	70°	64°	Hens very restless
6	5	"	0–98[2]	64°	51°	One hen shook the powder off
7[3]	5	"	98–100	71°	41°	
8[3]	4	"	95	"	"	
9[3]	5	"	80	"	"	

[1] Two hens about as badly infested as before treatment.
[2] One hen about as badly infested as before treatment.
[3] Dusted on two successive nights.

These data show that 32 out of 35 hens used were greatly benefited by the treatment, it being estimated that from 80 to 100 per cent of the lice had been killed or repelled. In Test 6 the one bird not benefited was known to have fluttered and shaken herself just after the naphthalene was applied. In Test 3 it was noted that the hens were very uneasy and it seems probable that the two which remained infested with lice also shook off the powder before settling down on the roost.

Although the lice were not completely eradicated a very material reduction in the number present was observed on over 90 per cent of the fowls and the results are about as good as would be obtained by dusting as it is ordinarily done.

It is not claimed that this method of treatment has been given an

exhaustive trial or that it should be generally adopted, but the results indicate that it may furnish a very rapid and convenient means of reducing the numbers of lice to a point where they will no longer be a serious problem.

It is hoped that some reader may be in a position to give this method a thorough test on a commercial scale.

Naphthalene Nest Eggs

The following tests were made to determine the value of naphthalene nest eggs which have been recommended as efficient agents for the control of lice on laying and setting hens.

Laying Hens. In these tests the eggs were placed in the nest used by laying hens which were known to be very lousy, and the hens were examined every week until they ceased to lay.

Table III gives the results of these tests.

Table III. The Results of Tests with Naphthalene Nest Eggs Against Lice on Laying Hens

Test No.	Per Cent of Naphthalene	Number of Hens Used	Duration of Test	Per Cent of Lice Killed or Repelled
1	100	2	8 days	0
2	100	3	17 "	0
3	100	2	24 "	0
4	100	4	25 "	0

This table shows that naphthalene nest eggs are of no value against lice on laying hens.

Since the length of time that a laying hen would remain on the nest and exposed to the action of the nest egg would vary with the individual hen and with the number of eggs laid during the test, further experiments were made to determine the effect of what was considered to be a maximum exposure. A box just large enough to hold a hen but in which it could not stand up, was made. The bottom of this box was covered with excelsior on which a naphthalene nest egg was placed. Two one-inch holes were bored in one end of the box to furnish ventilation. A hen, badly infested with lice, was placed in this box and the lid was closed so that the bird was forced to remain on the egg for about thirty minutes on the following dates: September 6, 7, 8, 10, 11 and 14. At the close of this experiment the hen was found to be as badly infested with lice as before treatment. This experiment was duplicated, using nest eggs containing 46.4 per cent and 6.9 per cent of naphthalene and the same results were obtained.

Setting Hens. In the tests against lice on setting hens the nest egg was placed with the setting of eggs and allowed to remain there during the entire experiment.

Table IV gives the results of tests with these nest eggs against lice on setting hens.

TABLE IV. THE RESULTS OF TESTS WITH NAPHTHALENE NEST EGGS AGAINST CHICKEN LICE INFESTING SETTING HENS

Test No.	Duration of Test	Results	Number of Chickens Hatched	Remarks
1	7 days	Not noted	0	Hen left nest
2	21 "	Still infested	0	Hen did not remain constantly on nest
3	14 "	Not noted	0	Hen left nest
4	11 "	Still infested	0	do
5	20 "	do	0	Hen did not remain constantly on nest
6	22 "	Not noted	6	4 hens used; three left the nest
7	9 "	Still infested	0	Hen left the nest
8	23 "	do	6[1]	Many mites in nest
9	23 "	Not noted	6[2]	6 hens used; 5 left the nest

[1] Three chickens died. [2] Four chickens died.

This table shows that, in every case where records could be taken, the naphthalene nest egg did not reduce the number of lice, although in Tests 2, 5 and 8 the hens remained more or less constantly on the eggs for about three weeks. These results were confirmed by examinations made at irregular intervals on the hens that left the nests.

It will be noted that in six of the nine tests the hens left the nests and in two other tests the hens did not set well, leaving only one hen that completed the full incubation period in a normal manner, and from this setting of sixteen eggs only three chickens survived. Tests 6 and 9 are of particular interest, since they show the effects of naphthalene nest eggs on setting hens under conditions of extremely hot weather. These tests were made in a barn where the temperature ran very high and the hens were all very seriously affected by the naphthalene eggs. After setting for a period ranging from one to four days, eight of the hens used left the nest, showing very pronounced signs of injury which in some instances lasted for several days. The symptoms were very similar to those produced by dusting with naphthalene, but were much more pronounced and recovery was much slower. The exact cause of this injury is not known, but it may be that the naphthalene is toxic when absorbed through the skin. That the naphthalene is taken into the body was determined by one experiment where a hen, that had been setting for some time on a nest egg containing only 6.49 per cent of naphthalene, was killed by the writer, and when cooked twenty-four hours later was found to taste so strongly of naphthalene that it could not be eaten.

The fact that only 18 chicks hatched from 75 eggs and that 7 of them died within 2 or 3 days would indicate a very pronounced injury from the naphthalene nest eggs, but since in almost every case the

hens did not "set well," it is impossible to determine the exact cause of this high mortality.

The failure of these eggs to control lice is probably due to the fact that naphthalene vapor is over four times heavier than air and, therefore, does not work up through the feathers, although, as previously mentioned, a certain amount is taken into the hen's body, probably from direct contact with the egg.

It might be added that in many of the tests the nests and even the naphthalene eggs themselves were found to be swarming with chicken mites (*D. gallinæ* Redi.).

Summary

1. Powders containing 5 per cent or less of naphthalene are of no value against lice.
2. Powders containing from 10 per cent to 20 per cent are very effective.
3. As little as 10 per cent naphthalene may temporarily injure hens, if the powder is well rubbed in, and 60 per cent or more may kill the treated fowls under the same conditions.
4. Naphthalene (60 to 100 per cent) sprinkled over the backs of fowls at roost proved to be of considerable value against lice.
5. Naphthalene nest eggs are of no value against lice on laying or setting hens.
6. The data obtained indicate that setting hens, the eggs and possibly any chickens hatched are injured by these eggs.

THE DEPLUMING MITE OF CHICKENS: ITS COMPLETE ERADICATION FROM A FLOCK BY ONE TREATMENT

By H. P. Wood, *U. S. Bureau of Entomology*

During the course of experiments with the control of poultry lice a few flocks infested with the depluming mite[1] were encountered.[2] Inasmuch as treatments heretofore have consisted merely of ointments applied to the parts visibly affected, it was deemed worth while to attempt to find a method of completely destroying the mites in an infested flock. After a few preliminary experiments we were fortunate in discovering a method which has obtained the desired results.

The depluming mite is found in a scale surrounding the base of the feathers. To discover the mite on infested fowls it is only necessary

[1] Known scientifically as *Cnemidocoptes gallinæ* Railliet.

[2] This investigation was carried out at the Dallas, Texas, laboratory of the Bureau of Entomology, under the direction of Mr. F. C. Bishop.

to pluck a few feathers from several regions of the fowl and examine with a lens the scales around the base of the quill. The head of the mite may be seen projecting slightly through the scale which is removed with the feather. This scale is larger than on a normal feather. It is often more difficult to find them on broken feathers than on whole feathers for the live mites are more often found on the whole feathers. Though in bad infestations either live or dead ones may be found on any feathers. As many as three adults have been found in one scale.

The adult female gives birth to larvæ still encased in the egg sack, the larva extricating itself from the egg sack soon after birth. Mites were found on feathers taken from back, top of wing, near vent, breast and thighs but none from tail or primary or secondary wing feathers. In the tunnel with a female were found thirty-one larvæ.

The damage to the plumage is very evident. Infested fowls have a ragged appearance with a good many broken feathers or perhaps bare spots. This appearance is more evident in the summer and fall than it is soon after molting. It is quite evident that any damage done to plumage would be detrimental to show birds. We believe also that more injury is done to poultry generally by this mite than is commonly supposed. There seems to be some itching which may result in feather pulling, causing some hens to become quite bare. The time fowls spend in combating this pest would better be spent in resting or getting food, thus producing increased growth or larger egg yield.

This mite seems to be quite generally distributed, according to reports of various authors. We have collections from Texas, and Mr. O. G. Babcock has sent us collections from Tennessee, Missouri and Mississippi. Even in infested districts, however, many flocks appear to be entirely free from the mites.

The following substances were tried out in preliminary control experiments: Lime-sulphur, potassium sulphuret, tobacco-sulphur, dry sulphur, arsenical dip (B. A. I. formula, white arsenic 8 lbs., sal soda 24 lbs., pine tar 1 gal., and water to make 500 gallons), kerosene emulsion, sulphur and sodium fluoride, sodium fluoride, soap and water, sulphur, soap and sodium fluoride. Sodium fluoride was included in the last two formulæ to see if both lice and the depluming mite could be killed in one treatment.

Lime-sulphur: One lb. lime, 2 lbs. sulphur, 1 gal. water. Dilution, 1 to 20 parts water. Fourteen days after treatment no live mites could be found; all lice were not killed.

Potassium sulphuret: One-half oz. soap, ½ oz. potassium sulphuret, 1 gal. water. Sixteen days after treatment some mites found alive.

Tobacco-sulphur: Three teaspoonfulls "Black Leaf 40," 6 ozs. sulphur, 2½ gal. water. Eleven days after treatment no live mites or lice found.

Dry sulphur: Thoroughly dusted with flowers of sulphur. Twelve days after treatment no live mites found.

ARSENICAL DIP (B. A. I. formula): Made about three months, exact strength at time used not known. Fifteen days after treatment no live mites found.

KEROSENE EMULSION: Two gals. kerosene, ½ lbs. soap, 1 gal. water. Dilution, 1 to 10. Thirty-nine days after treatment no live mites found but fowl's skin was injured by burning.

SULPHUR AND SODIUM FLUORIDE: Two-thirds oz. NaF., 2 ozs. sulphur, 1 gal. water. Five days after treatment one live mite found. A later observation should have been made.

SODIUM FLUORIDE, SOAP AND WATER: Three-fourths oz. NaF., ½ oz. whale oil soap, 1 gal. water. Sixteen days after treatment live mites found.

SODIUM FLUORIDE, SULPHUR, SOAP AND WATER: Two-thirds oz. NaF., 2 ozs. sulphur, soap (enough to make the water soapy), 1 gal. water. Sixteen days after treatment no live mites found.

In these experiments one hen was used in each experiment. The birds were held under the solution about one minute, during which time the feathers were thoroughly ruffled and the heads ducked two or three times.

SUMMARY OF PRELIMINARY EXPERIMENTS IN DEPLUMING MITE CONTROL

Substance Used	All Mites Killed	Injurious Effect
Lime-sulphur	Yes	None
Potassium sulphuret	No	None
Tobacco-sulphur	Yes	None
Dry sulphur	Yes	Negligible
Arsenical dip	Yes	None
Kerosene emulsion	Yes	Injurious
Sulphur and sodium fluoride	No	None
Sodium fluoride, sulphur and soap	Yes	None

Of these substances, lime-sulphur, tobacco-sulphur, dry sulphur, B. A. I. Dip, and sodium fluoride, sulphur and soap were effective. Inasmuch as we have found sodium fluoride so effective against lice we thought it advisable to try on a larger scale to see if both the lice and depluming mite could be eradicated at one treatment.

June 30, 1917, 48 fowls infested with lice and the depluming mite were dipped in a solution of sodium fluoride (chemically pure) ⅔ oz., sulphur 2 oz., soap (laundry) ⅓ oz. (about), water 1 gal. A number of feathers were plucked from the treated fowls 27 days, 55 days, and about 5 months, 6½ months, 11 months, 1⅓ years after treatment and at no time were living mites or lice found.

A warm day was selected to treat the fowls and there was no injury to them. The experiment may, therefore, be considered, a complete success. A subsequent experiment on 120 hens infested with depluming mites, treated June 5, 1918, in the same way as in the above experiment and observed until January 17, 1919, verified the results of the previous experiment.

EUROPEAN CORN BORER CONFERENCE

A conference of about fifty Commissioners of Agriculture, official entomologists, inspectors, etc., representing twenty-two states, in addition to officials from the U. S. Department of Agriculture, and from the Dominion of Canada, was held at Albany, N. Y., August 28, and at Boston, Mass., August 29.

At Albany, the opening meeting was held in the forenoon in the State Education Building, after which a luncheon was given by the New York State Museum. In the afternoon all visited the infested corn fields in the vicinity of Schenectady, being transported in motor cars. A meeting of Commissioners of Agriculture was scheduled for the evening, and the entomologists gathered for an informal meeting where was freely discussed the general policy of suppressing the corn borer.

Reservations had been made on the night train for Boston, and at the morning meeting at the State House, a brief summary of the situation in Massachusetts was given by Mr. Wilfred Wheeler, commissioner of agriculture. The corn borer laboratory in Arlington was then visited where Mr. D. J. Caffrey gave an interesting account of the life history of the European corn borer as revealed in two years' work with this insect in Massachusetts. After a luncheon furnished by the Arlington Board of Trade, an inspection was made of some infested fields, and demonstrations were given of methods of burning weeds and of crushing stalks to kill the larvæ in them. A visit was also made to the gipsy moth laboratory, Melrose Highlands, and on the way one of the automobile truck power sprayers was seen in action.

Finally the committee on resolutions, appointed at the first session in Albany, submitted the following report which was adopted by the conference:

BOSTON, August 29, 1919.

Whereas, the European corn borer has become well established in both Massachusetts and New York state, and during the past two years, has seriously damaged both sweet and field corn in Eastern Massachusetts, and

Whereas, it has spread rapidly this season and will, unless speedily checked in both states, spread quickly over large areas heretofore uninfested and in a few years may cause enormous losses which might run into many millions of dollars.

Therefore, we, the National Association of Commissioners of Agriculture, with official entomologists from many states and representatives of the U. S. Department of Agriculture, together with representatives of the Canadian Government, present as experts in conference upon the situation, express ourselves, after examining the infested area, as thoroughly convinced that this pest is one of the most dangerous insects which has become established in America, and we hereby place ourselves on record in favor of most energetic efforts on the part of federal and state agencies to control, and, if possible, exterminate this insect, including in the program vigorous quarantines to prevent its distribution.

The danger of spread is so great, the probabilities of successful control under American conditions so unpromising, that we unhesitatingly recommend most energetic measures to control this very serious enemy of our principal grain crop. The immensity of the interests threatened leads us to advise a comprehensive plan of action which may involve the expenditure by the general government of much larger sums than are recommended in these resolutions.

We urge the present Congress to appropriate and make available for use as rapidly as an effective organization to carry on the work can be secured and developed, in addition to funds already available, two million dollars, the sum to be requested for the calendar year of 1920, to be determined by the future developments of the work.

We would at this time call attention to the necessity of all commissioners of agriculture and entomologists throughout the United States of America and Canada, taking an active interest in this insect, and we would hereby urge the dissemination of information respecting the situation by the appropriate agencies in each state and by the Federal Government.

We would recommend for the purpose of promoting the control and extermination of this borer the appointment of a committee representing the commissioners of agriculture; official entomologists and the Plant Pest Committee for the purpose of unifying and directing all efforts for the securing of appropriations and to aid in the determination of a comprehensive policy.

C. P. Norgord, *Commissioner of Agriculture*, Wisconsin.
Charles McCaffree, *Industrial Commissioner*, S. Dakota.
Wilfrid Wheeler, *Commissioner of Agriculture*, Massachusetts.
E. P. Felt, *State Entomologist*, New York.
George A. Dean, *Professor of Entomology*, Experiment Station, Kansas.
R. W. Harned, *State Entomologist*, Mississippi.
Committee on Resolutions.

Among those in attendance, the following entomologists were noticed: E. D. Ball, Iowa; A. F. Conradi, South Carolina; E. N. Cory, T. B. Symons, Maryland; E. C. Cotton, Ohio; G. A. Dean, Kansas; E. P. Felt, P. J. Parrott, G. W. Herrick, J. G. Needham, C. R. Crosby, M. D. Leonard, D. B. Young, E. A. Rundlett, New York; H. T. Fernald, W. M. Wheeler, C. T. Brues, Massachusetts; W. P. Flint, Illinois; Philip Garman, W. E. Britton, Connecticut; R. W. Harned, Mississippi; T. J. Headlee, John J. Davis, New Jersey; H. E. Hodgkiss, Pennsylvania; Wilmon Newell, Florida; W. C. O'Kane, New Hampshire; R. H. Pettit, Michigan; A. G. Ruggles, Minnesota; E. E. Scholl, Texas; A. E. Stene, Rhode Island; C. G. Hewitt, J. B. McLaine, William Lochhead, Dominion of Canada; L. O. Howard, C. L. Marlatt, A. F. Burgess, W. R. Walton, L. H. Worthley, D. J. Caffrey, R. I. Smith, U. S. Department of Agriculture.

The proceedings of the conference will be published at an early date by the New York State Department of Farms and Markets, Division of Agriculture. A copy may be secured by application to Hon. C. S. Wilson, Commissioner of Agriculture, Albany, N. Y.

W. E. B.

Scientific Notes

An Imported Feeder on Stored Peanuts. While inspecting warehouses for the State Food Administrator, a heavy infestation of a moth, resembling *Ephestia kuehniella,* was found in peanuts imported from China. About five hundred tons of peanuts had been stored on this floor for six months. The bags were piled about ten deep, while the infestation was confined mostly to the two or three upper layers. Many of the sacks in the upper tier were completely covered by the silken web which the caterpillar spins, in this way also resembling the Mediterranean flour moth. The loss, as with most insects attacking stored foods, came not alone in the destruction of the peanut kernel but in the large amount of frass and webbing present on the uneaten nut. Both hulled and unhulled peanuts were attacked. The deterioration was so marked that the attention of the State Food Inspector was called to the infestation and he promptly confiscated the most heavily infested portions.

The larvæ pupated between the sacks or on the walls and ceilings, there being apparently two or more generations through the summer. Caterpillars pupating in October did not emerge in the laboratory until the first part of April.

The male moth is 10 to 12 mm. long, light gray in color, with a yellowish brown stripe 4 to 5 mm. long in the center and lengthwise of the wing. A distinct black spot is found at the posterior end of this stripe. The female moth is 15 to 16 mm. long, a uniform grayish color, distinctly lighter than *E. kuehniella.* The fore wings show no other markings except a deep black spot about 8 mm. back from the base of the wing. The larvæ are of the same general appearance as *E. kuehniella.*

This moth was identified by Mr. August Busck as *Aphomia (Paralipsa, Melissoblates) gularis,* Zeller of the family *Galleridæ.* It was described (Horae. Soc. Entom. Rossicæ, vol. xiii, p. 74, pl. 1, fig. 26, plate 2, fig. 27, 1877) from Japan and recorded from China, India and Valdivostock. He comments as follows, "It is presumably a scavenger, feeding in the decayed peanuts and it might well prove of some economic importance if it was introduced into the United States. It is the first record of its coming to our shores as far as I know."

E. R. de Ong, *University of California.*

The Imported Red Spider (Paratetranychus pilosus Can. & Fanz.) Attacking Apple Foliage. This mite has been reported from Canada by Mr. L. Caesar but has not hitherto been recorded from the United States. Specimens of this mite were kindly determined by Dr. H. E. Ewing through the courtesy of Dr. A. L. Quaintance. The European plum seems to be its preferred host, although it has been found, according to Caesar, on apple, sour cherry, pear, peach, hawthorn, mountain ash and rose. It has become established on apple in Adams County, Pennsylvania. Specimens have been taken from widely separated orchards throughout the county. The foliage of infested orchards becomes brownish or yellowish in color and presents a very sickly appearance. Reports of similar injury have been received from Franklyn County, Pennsylvania, which may prove to be caused by the same species.

Injury by this species was first noted during the summer of 1918, although the owner of one orchard states that he has noticed similar injury for the past three or four years. During the winter of 1918–1919 the eggs were found very abundant in orchards where the injury had been serious the previous summer. The smaller branches were covered with eggs, especially on the under sides, giving the branches a reddish color and attracting the attention of many. In the spring the first reports were received from laborers, working in orchards, who were annoyed by the abundance of these mites and the tickling sensation produced by those which had fallen from the trees.

The mite, on first glance, looks like *Tetranychus bimaculatus* but can readily be separated from this species by the fact that in *P. pilosus* Can. & Fanz., the bristles arise from prominent tubercles.

S. W. FROST, *Research Laboratory, Arendtsville, Pa.*

European Corn Borer (*Pyrausta nubilalis* Hubn.). The past few weeks have demonstrated that but one generation of this pest will occur this year in the known New York infested area. This, if it proves to be normal, means a greatly reduced probability of injury for much of the corn growing area of New York state, though in the warmer parts, for example south of Poughkeepsie, no such exemption from a second brood with probable serious losses can be expected. This not altogether unanticipated development has little bearing upon the behavior of the insect in the corn belt where the longer season is favorable for presumably two and possibly three generations with accompanying serious injuries. An infestation in New York territory, even if there be but one brood, is a constant menace because of the opportunities for spread.

The recent discovery at North Collins, Erie County, of a corn borer now identified as *Pyrausta nubilalis* means an infestation three hundred miles west of anything heretofore known to exist. It also suggests the possibility of the moths having been carried by railway trains, since this infestation is within five miles of the Lake Shore Michigan Southern Railway. The Schenectady area is traversed by the main line of the New York Central and also has near its center Rotterdam Junction with direct railway service over the Boston and Maine from the older infested area near Boston, Massachusetts. There is fair to good railway service between the three points. The recent find and the relationship existing between the occurrence of the insect and railways is worthy of careful consideration.

E. P. FELT.

ANNUAL MEETING, AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

ST. LOUIS, MO., DECEMBER 31, 1919 TO JANUARY 1 AND 2, 1920

The 32nd Annual Meeting of this Association will be held at St. Louis, Mo., on the above-mentioned dates. Notices have already been sent to members with a request for titles of papers which they may wish to present at this meeting. Titles must be in the hands of the secretary by November 8, in order to have a place on the program. Applications for membership may be secured from the secretary or from the chairman of the Committee on Membership. It is desired that all applications be filled out, endorsed, and placed in the hands of the chairman of that committee prior to the time of the meeting. It is hoped that the forthcoming meeting at St. Louis will be largely attended, and that it will be one of the best meetings the association has held for many years.

A. F. BURGESS, *Secretary*.

Dr. Edna Mosher, recently of the Ohio State University, has accepted a position in the Department of Biology, University of New Mexico, Albuquerque, N. Mex.

// JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

OCTOBER, 1919

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photoengravings may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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The European corn borer conference at Albany and Boston suggested to some of the older men the summer meetings of years ago, except that it was held a little later in the month and was limited to the consideration of one insect and its associated problems. The summer meeting affords an opportunity to learn at first hand concerning local problems, and the advantages accruing should not be limited, as has been the case during recent years in the eastern United States, to such infrequent occasions as a general consultation concerning a pest of major importance. It is suggested that the matter be kept in mind, since conditions may make it possible to have an occasional summer meeting with some other group of scientists or, if this is not feasible, there might be a smaller gathering to serve the special interests of one section of the country.

The informal session of entomologists held at Albany the evening of August 28 resulted in a better general understanding of policies, though it did not appear to the writer that there was much real difference in opinion. It was more a question of the use of words and the desirability of being explicit in stating limitations. No one conversant with the difficulties incident to control and extermination work with insects could object to such an attitude, and judging from conversations and correspondence since the conference, the resolutions as adopted represent very fairly the consensus of opinion.

Since the St. Louis meeting promises to be unusually important, there should be a large and representative attendance. Changes of fundamental importance in relation to the organization of the Association will be presented for final action. Their import should be understood by all before a vote is taken. The effects of profound social and

economic changes are making themselves manifest and readjustments accompanied by searching scrutiny are bound to occur. Some of these will have a vital bearing upon the professional man. Adequate compensation is as essential in science as in other lines. The recent demonstrations of the power of organized effort have opened new fields of usefulness and increased responsibility accordingly. Have these developments any relation to entomological problems? If such be the case, how can they be utilized? Have the broader phases of entomology received due attention? Can plans be developed which will result in the more comprehensive handling of the numerous problems constantly brought to the attention of the economic entomologist?

Reviews

Class Book of Economic Entomology, with Special Reference to the Economic Insects of the Northern United States and Canada, by WILLIAM LOCHHEAD, Philadelphia: P. Blakiston's Son & Co., p. i–xiv, 1–436, 257 text figures, 1919. Price, $2.50 net.

The author has condensed in this volume a large amount of information, and deals with the subject in a most comprehensive manner. The first part discusses with the structure, growth and economics of insects, fundamental matter of great importance to the student or individual interested in some phase of insect control. The second and third parts are devoted to insects affecting various crops. Part two, a tabulation designed to facilitate the identification of the pest through its operations, is a most valuable feature. The individual accounts of pests in part three are grouped systematically and only the essentials are given for each species. The identification of the difficult aphids or plant lice is made easier by a brief key to the chief economic genera and a partial list of species having two plant hosts. The author has not hesitated to add other keys where desirable. Part four is limited to a discussion of control methods, insecticides and the utilization of parasitic insects. There is also a well chosen bibliography and a glossary.

The volume, while designed particularly for the classroom, will prove extremely serviceable to many desirous of obtaining a comprehensive idea of insect life. There is an excellent series of illustrations (*Advt.*). E. P. F.

NOTICE CONCERNING BACK NUMBERS OF THE JOURNAL

After January 1, 1920, the price of all back numbers of the JOURNAL OF ECONOMIC ENTOMOLOGY will be $3.50 per volume, or 75 cents per single number. The supply of Volume 1 is exhausted, but single numbers of this volume that remain on hand can be furnished for 75 cents a copy. Prior to the first of January, 1920, back numbers can be secured at the present rate of $2.50 per volume or 50 cents per copy. This rate does not apply to copies of Volume 1, which will be sent at the rates quoted above.

Bank's Index to the Literature of Economic Entomology can be furnished for $5.00 a copy. Fifty cents additional should be added to the price of each volume or copy of Bank's Index, if shipment is to be made to foreign countries. Anyone needing back numbers will do well to purchase them before the end of the year.

A. F. BURGESS, *Secretary.*

Melrose Highlands, Mass.

Current Notes

Conducted by the Associate Editor

Mr. S. Marcovitch has accepted a position with the Tennessee State Board of Entomology as research assistant.

Mr. George G. Becker has been appointed chief inspector of the Arkansas State Plant Board, vice J. Lee Hewitt, resigned.

Mr. Thomas L. Guyton has resigned from the Bureau of Plant Industry of the Department of Agriculture of Pennsylvania.

Mr. Stanley B. Freeborn has returned from service and has been appointed assistant professor of entomology in the University of California.

Mr. F. B. Paddock has resigned as state entomologist of Texas to take effect September 15, to assume the duties of state apiarist of Iowa.

Mr. C. C. Hamilton resigned August 1 as extension entomologist of the Missouri Agricultural Extension Service to enter commercial work.

Miss M. E. Stehle, assistant professor in Zoölogy and Entomology, Clemson College, spent the summer at Woods Hole doing advanced work.

Dr. H. E. Ewing has spent the summer season in the U. S. National Museum doing systematic work on the mites for the Bureau of Entomology.

Mr. T. T. Haack, formerly deputy inspector in Wisconsin, is acting as assistant state leader in charge of barberry eradication in the same state.

A field laboratory has been established by the Ohio Station in the trucking district at Marietta, Ohio, in charge of Mr. W. V. Balduf during the summer.

Mr. W. H. Hambleton returned this month to his position as instructor in entomology and apiculture in the College of Agriculture, University of Wisconsin.

Mr. G. M. Anderson, formerly extension entomologist at Clemson College, has accepted a position as research entomologist, beginning his duties on August 1, 1919.

Mr. Edmund H. Gibson has resigned from the Bureau of Entomology to take up professional work in entomology with headquarters for the present at Alexandria, Va.

Mr. C. R. Phipps, a graduate of the Massachusetts Agricultural College, has been appointed assistant entomologist of the Agricultural Experiment Station at Geneva, N. Y.

Messrs. P. G. Plumley and J. L. Wood, Jr., have recently been added to the corps of nursery and orchard inspectors, working under the Tennessee State Board of Entomology.

Experimental apiary work has been inaugurated in the Entomological Department of the Agricultural Experiment Station, College Station, Texas, with Mr. H. B. Parks in charge.

Prof. K. C. Sullivan of the University of Missouri, Columbia, Mo., prepared an educational exhibit of economic insects for the state fair which attracted unusual attention.

Mr. Russell M. Hain has recently been appointed as an expert on insect troubles in the extension department of the Michigan Agricultural College and began his duties September 1.

Mr. B. B. Fulton, assistant entomologist of the New York (Geneva) Agricultural Experiment station, has been appointed assistant professor of entomology at the Oregon Agricultural College.

Dr. Philip Garman of the Maryland Agricultural Experiment Station has resigned to accept a position in entomological research at the Connecticut Agricultural Experiment Station, New Haven, Conn.

Mr. W. A. Thomas of the State Department of Agriculture, Raleigh, N. C., will resume investigational work with the Bureau of Entomology on truck crop insects and will be stationed at Chadbourn, N. C.

Mr. Harry L. Fackler, who has been an assistant of Prof. S. J. Hunter of Lawrence, Kan., has accepted the position of assistant entomologist for the State Board of Entomology, care University of Tennessee, Knoxville.

Mr. Thomas L. Guyton has resigned as assistant entomologist of the bureau of Plant Industry of the Pennsylvania Department of Agriculture, to complete his work for a doctor's degree at the Ohio State University.

Mr. Frank D. Garrison of Ellijay, Ga., has been secured as the industrial and commercial secretary of the Tennessee State Horticultural Society, with office located with the state entomologist, University of Tennessee, Knoxville.

The Florida legislature at its session just closed, enacted a law providing for the eradication of diseases of honey bees. The execution of the law is placed in the hands of the State Plant Board, and the appropriation is $5,000 per annum.

Messrs. Pierce, Finn, Stear, Buckman and Benn together with some temporary assistants are engaged in scouting in the coal region of Westmoreland, Fayette, Allegheny, Washington and Green counties, Pennsylvania, for the potato wart.

Prof. R. A. Cooley, entomologist of the Montana Experiment Station and state entomologist, after having been in Massachusetts on leave of absence for the summer, has returned to Montana. During his absence Mr. J. R. Parker was in charge.

A caterpillar closely resembling the European corn borer has been found at Ravenna, Ohio. However, from the restricted numbers of the insect, it is hoped that it will turn out to be a native *Pyrausta*. Moths from the caterpillars have not yet been secured.

Mr. M. R. Smith, research assistant in entomology at the South Carolina Agricultural Experiment Station, has accepted a position with the North Carolina State Department of Agriculture as research and extension entomologist and began his duties on August 1, 1919.

Mr. C. L. Marlatt, chairman of the Federal Horticultural Board, delivered addresses before the American Association of Nurserymen at Chicago June 26, and the society of American Florists and Ornamental Horticulturists at Detroit August 21, in regard to quarantine order No. 37.

Dr. H. A. Morgan, formerly entomologist of the Agricultural Experiment Station, and professor of entomology in the University, and more recently director of the Station and dean of the College of Agriculture, has recently been elected president of the University of Tennessee.

Mr. H. E. Woodworth, recently appointed horticultural commissioner of San Mateo County, California, is directing a campaign, now nearly finished, against the horse bean weevil, involving the fumigation of the entire crop of horse beans, amounting to about 3,000,000 pounds.

Mr. G. A. Coleman has returned from a summer school in beekeeping which he conducted at Sur, Monterey County, California. He obtained additional moving picture films representing beekeeping operations and expects ultimately to have a very exhaustive set of these films.

Mr. H. L. Seamans, formerly assistant state entomologist of Montana and recently released from military service, will substitute for Mr. M. H. Spaulding, assistant professor of zoölogy, in the Montana State College of Agriculture and Mechanic Arts during the coming college year.

Mr. N. F. Howard, formerly of the Bureau of Entomology, stationed at Madison, Wis., who has been serving in the Sanitary Corps in France for about a year, returned the first of August and has accepted a position in the Efficiency Department of the Goodrich Rubber Company, Akron, Ohio.

Prof. Leonard Haseman of the University of Missouri, Columbia, Mo., spent the month of August at Ithaca, N. Y., and made a hurried auto trip through a part of the European corn borer, and gipsy and brown-tail moth infested areas of New York, Massachusetts, Rhode Island and Connecticut.

A feature of the past year's work at Clemson College is the activity in extension work for the development of beekeeping. Mr. E. S. Prevost is in charge of this, and a great amount of work was done throughout the state in transferring, requeening and preparations of bees for outdoor wintering.

Mr. L. J. Hogg, formerly assistant in cereal and forage crop insect investigations, Bureau of Entomology, and attached to the laboratory at Tempe, Ariz., died suddenly July 8 of acute peritonitis. At the time of his death, Mr. Hogg was acting as agricultural specialist for a large copper concern in Arizona.

Mr. E. R. De Ong has just completed a survey of the well waters, about 500 wells in the Santa Clara Valley, to determine their hardness for the purpose of prescribing appropriate formulæ for oil emulsions. Great variations were found which accounts for the complaints of the users of this insecticide in that locality.

Mr. Ralph Oertli, Mr. Bernard Iverson and Mr. Jacob Bulger have been appointed assistants in the Entomology Department of the South Dakota State College. Mr. Oertli will assist in the State Experiment Station work, while Messrs. Iverson and Bulger will be connected with the office of the state entomologist.

Capt. R. D. Whitmarsh has resigned his position at the Ohio Station and accepted work with the Corona Chemical Co., Milwaukee, Wis. He will develop a scientific department for the company dealing with entomology and plant pathology. He will also have charge of considerable work, more or less of a commercial character.

Dr. W. Dwight Pierce, who has been connected with the Bureau of Entomology for fifteen years, has severed his connections with the Department and will open up a general entomological consulting and commercial practise with headquarters, probably at Boise, Idaho. His temporary address is 1545 South 19th St., Lincoln, Neb.

Mr. E. O. Essig, who served as farm advisor for Ventura County, California, during the war period and has just held the position of manager of the selling agency for the Lima Bean Growers' Association in which capacity he sold over 250 carloads of beans, has now returned to his professorship in entomology at the University of California.

The following entomologists attended the hearing "On Account of the Flag Smut and Take-All Diseases of Grains and the Wheat Nematode or Eelworm Disease," before the Federal Horticultural Board of Washington, D. C., on July 15: W. J. Schoene, Virginia; Frank N. Wallace, Indiana; A. C. Lewis, Georgia; P. A. Glenn, Illinois.

Dr. William Colcord Woods was granted leave of absence by Wesleyan University for the period of the war. When he returned from France in April he went as member of the summer staff in entomology to the Maine Agricultural Experiment Station at Orono. September 1 he returned to Wesleyan University as assistant professor of biology.

Mr. W. J. Price, who has been connected with the office of the state entomologist in Virginia since 1902, and who for the past eighteen months has been connected with the increased production work in that state for the Bureau of Entomology, has accepted a position in the Department of Agricultural Education, and will be located at Woodstock, Va.

Mr. M. B. Dunn, temporary assistant at the Dominion Entomological Laboratory at Fredericton, N. B., has been appointed an entomological assistant in the Division of Forest Insects of the Entomological Branch, Ottawa, and under the direction of Dr. J. M. Swaine he will be assigned to sample plot investigations in the forests of Quebec and Ontario.

Mr. S. B. Freeborn, since his return from the Army, has been investigating the malaria situation in the northern Sacramento Valley, and is at present directing a campaign in the neighborhood of Anderson to which the State Board of Health has contributed $10,000 in addition to the sum raised by the Mosquito Abatement District organized there.

On August 13, there was held at the State College of Washington, a joint meeting of the horticulturists and entomologists of the northwestern states. The day following, a continuation of this meeting was held at the University of Idaho at Moscow. A year ago, a similar meeting was called at the Oregon Agricultural College which was very successfully attended.

Mr. H. K. Harley of the state entomologist's office, Madison, Wis., spent the week of August 18 to 23 in the neighborhood of Boston, Mass., studying the European corn borer. Mr. Harley is making a survey of Wisconsin, and especially of those areas into which New England seed corn was imported in 1918, to determine if possible whether the corn borer was imported into the state at that time.

A new project dealing with the wire worms affecting wheat has been inaugurated by the Washington Experiment Station in coöperation with the Bureau of Entomology. Frank W. Carlson has been appointed station investigator with headquarters at the Dry-Land Experiment Station at Lind, and F. R. Cole has been delegated by the Bureau of Entomology as collaborator on this work.

The following resignations from the Bureau of Entomology are reported: Geo. A. Hummer, to resume commercial beekeeping; E. W. Scott, in charge of insecticide laboratory, Vienna, Va., to become manager of a newly-formed company, with headquarters at Rockville, Md.; M. D. Leonard, extension entomologist, truck crop insects, New York State, to accept a position at Cornell University Agricultural Experiment Station.

Prof. George B. Neumann recently returned from service in France has been appointed assistant in entomology at the Purdue University Experiment Station,

LaFayette, Ind. Mr. Neumann graduated from the University of Maine in 1914 and received his masters degree at Cornell University in 1915. He was connected with the Department of Entomology, State College of Pennsylvania, for three years before going into the service.

Dr. Charles H. Gage, chemist and metallurgist, and Dr. W. Dwight Pierce, entomologist, have formed the Gage-Pierce Research Laboratories. Their mail address is P. O. Box 1767, Denver, Colorado. It is expected that a number of laboratories will be constructed and a large group of commercial research scientists employed. Entomological control work will be one of the branches of work carried out by the consulting entomologists under Dr. Pierce's direction.

A five day orchard tour was conducted in Kansas, September 1 to 5, by E. G. Kelly, extension specialist, Kansas State Agricultural College, with the following county agents coöperating: W. A. Wunsch, E. J. Macy, W. A. Boys, F. J. Robbins, E. H. Ptacek, H. S. Wilson, J. V. Quigley, I. N. Chapman, A. D. Folker, F. H. Dillenback and O. C. Hagans. The trip included some of the best orchards of the state and not only orchardists, but men in other lines of business were invited.

Mr. S. I. Kuwana, director of the Imperial Quarantine Board of Japan is now in the United States, and inspected the work of the Department of Entomology of the Kansas State Agricultural College September 10. The next day Prof. George A. Dean accompanied Mr. Kuwana to Kansas City, where he was given an opportunity to inspect some of the large flour mills and grain elevators, and to study American methods of handling flour and grain to prevent and control insect injury.

The teaching section of the Entomological Department, Clemson College, S. C., is being considerably strengthened with equipment both in the Zoölogical Laboratory and class room and in the Laboratory of Economic Entomology. The latter work consists principally of the installation of spraying and dusting machinery, temperature moisture control apparatus, fumigation and cold storage and is arranged so as to teach the fundamental principles and not the practice. The course in practical work follows the same line as heretofore.

At the last session of the Washington state legislature, a bill was passed providing for inspection of bees and for educational propaganda regarding beekeeping. The work was assigned to the entomologist of the State College with authority to appoint instructors. Mr. H. A. Scullen, at present extension entomologist on apiculture for the northwestern states, has been designated part-time inspector with headquarters at Pullman. Mr. Scullen will divide his time between extension work, inspection, and instructional work at the State College.

During the season 1918, the Washington Experiment Station in collaboration with the Bureau of Entomology carried on a study of cranberry insects with headquarters at Seaview, Wash. Mr. H. K. Plank was assigned to this work by the Bureau of Entomology and A. Spuler and Miss Orilla E. Miner carried on the work on behalf of the Washington Experiment Station. This year the same project has been continued, the Experiment Station furnishing Miss Flora A. Friese. As evidence of the close coöperation, Mr. Plank and Miss Friese were married June 21.

The following transfers have been made in the Bureau of Entomology: H. A. Scullen, special field agent for Washington, Oregon and Northern Idaho to coöperative work in bee culture with the state of Washington; H. D. Young, California citrus-fruit insect investigations to the Insecticide and Fungicide Board; W. S. Fields, Bureau of Plant Industry to Federal Horticultural Board; R. W. Kelley, experimental field work to take charge of Insecticide and Fungicide Laboratory at Vienna, Va.; E. V. Walter, extension work in Iowa to investigational work at Tempe, Ariz.

Mr. Leonard S. McLaine, M.Sc., of the Canadian Entomological Branch, has been transferred from the Dominion Entomological Laboratory, Fredericton, N. B., to Ottawa, and has been appointed chief of the Division of Plant Inspection and executive assistant to the Dominion entomologist. As chief of the Division of Plant Inspection, Mr. McLaine will have immediate charge of the work of inspection and fumigating imported nursery stock, and of the field work against the brown-tail moth in Eastern Canada, and such other duties as the enforcement of the insects and pests regulations under the Destructive Insect and Pest Act may involve.

At the convention of Southern Nurserymen, held at Atlanta on August 20–21, a committee consisting of Messrs. E. W. Chattin of Winchester, Tenn., Charles Smith, Augusta, Ga., Henry Chase, Chase, Ala., and Professors George C. Starcher, Auburn, Ala., A. C. Lewis, Atlanta, Ga., and G. M. Bentley, Knoxville, Tenn., was appointed by the association to frame rules and regulations pertaining to the uniform inspection laws of nurseries. This committee held a very important meeting and framed the rules and will meet with the federal horticultural inspectors at their annual meeting in December. It is to be hoped that a uniformity of inspection laws may be perfected at that time.

Dr. W. Dwight Pierce has edited and revised the series of lectures on the entomology of disease, hygiene and sanitation and has added several new chapters to form a volume entitled "Sanitary Entomology," which will be published by Richard G. Badger of Boston. The proceeds of the royalties will be given to the Washington Entomological Society. Advance orders for the volume which will sell at $10 are desired in order to cover a guarantee made to the publishers. These are lectures by ten specialists, and the work represents the very latest official information on the subject. Doctors and sanitarians will be as much interested in this volume as entomologists and zoölogists.

New appointments have been made in the Bureau of Entomology as follows: George H. Rea, apicultural extension New York state; Emory G. Shanks, temporary laboratory helper, tropical and subtropical fruit insect investigations; John H. Harmon, Thomas F. Murphy, Roger J. Chambers, H. E. Partridge, Arnold F. Leamy, Earl D. Lathrop, European corn borer investigations; Lee Roy Wilbank, George Lee Lott, H. C. Young, B. F. Ware, G. A. Hammett, James Benford Pope, George W. Alexander, Lloyd W. Brannon, Clarence H. Brannon, James P. H. Clayton, Amos L. Williamson, George S. Fricke, Ben Matt Davenport, temporarily to boll weevil laboratory; Ernest L. Chambers, green house insects.

A coöperative agreement has been perfected between the Wisconsin State Department of Agriculture, the Agricultural Extension Service of Wisconsin, and the U. S. Bureau of Entomology, whereby Mr. H. L. McMurry is to become extension field agent and apiary inspector in that state. The educational and extension work will be conducted by Mr. McMurry under the direction of Prof. H. F. Wilson, entomologist of the Experiment Station; and the apiary inspection, as well as the educational work concerning the control of bee diseases, under the direction of Dr. S. B. Fracker, acting state entomologist. The last legislature passed a new apiary inspection law, placing its administration in the hands of the state entomologist, and requiring, in addition to the usual provisions of such laws, that permits be secured from the state entomologist for the sale or transportation of any bees or used apiary appliances.

Mailed October 22, 1919.